ROTHAMSTED
RESEARCH

Results of the

Classical and other

Long-term Experiments

2019

Contents

Conventions

For each experiment the current treatments are shown with the factor and level names which are used in the tables.

For each experiment references are given to previous years. These refer to the '(Numerical) (Results)' previous editions of 'Yields of the Field Experiments'.

For the classical and some long-term experiments reference is made to 'Details' – separate publications, giving full descriptions of treatments until 1977 & 1973, with full titles 'Details of the Classical and Long Term Experiments up to 1977' and 'Details of the Classical and Long Term Experiments up to 1973'.

The following conventions are observed unless otherwise stated.

All areas are in hectares. All plot dimensions are in metres.

All rates of application of fertilizers, sprays etc. are per hectare.

All yields are per hectare.

For any other crop, details of abbreviations are given as necessary

FERTILIZERS

27%N or 34.5% N means nitrogen as calcium ammonium nitrate or ammonium nitrate.

Anhydrous Sulphate of Soda	
Chalk	
Compost	
Double Top	27% nitrogen and 30% SO_3
FYM	Farmyard manure (from bullocks)
Headland Manganese 500	500 g/l 27.5% w/w manganese carbonate
Kieserite	$MgSO_4H_2O$ 17.7% magnesium and 23.3% sulphur
Maize Tops	
Manganese sulphate	$Mn_2 (SO_4)_3$ 27% manganese and 24% sulphur
Magnesium sulphate	$MgSO_4 H_2O$ 17.7% magnesium and 23.3% sulphur
Muriate of potash (MOP)	60% K_2O as Potassium Chloride (KCl)
Nitram	34.5% N
Nitraprill	34.5% N
Nitrate of soda	$NaNO_3$ 16% nitrogen and 27% sodium

Nitro-Chalk	Calcium Ammonium Nitrate 27% N
Silicate of soda	Na_2SiO_3 37% sodium and 23% silica
Sodium Sulphate	35% Sodium
Sulphate of ammonia	$(NH_4)_2SO_4$ 21% nitrogen 24% sulphur
Sulphate of potash (SOP)	K_2SO_4 50% K_2O and 18.4% sulphur
Triple superphosphate (TSP)	47% P_2O_5

Cereal straw is removed unless otherwise stated.

GS: Growth Stage.
tm): Tank mix; two or more products applied together.
tr: means seed dressing

PESTICIDES USED

The following list of pesticides is based on The UK Pesticides Guide, CAB International and The British Crop Protection Council. CABI Publishing

KEY TO ABBREVIATIONS

ad	Adjuvant	d	Desiccant	f	Fungicide
gr	Growth regulator	h	Herbicide	i	Insecticide
m	Molluscicide	n	Nematicide	tr	Trace elements

Trade Name	Function	Active ingredient
Ally Max SX	h	metsulfuron-methyl + tribenuron-methyl (14.3:14.3 % w/w)
Aphox	i	pirimicarb (50% w/w)
Artemis	f	fenpropidin + prochloraz + tebuconazole (250:200:100 g/l)
Bassagran	h	(87% w/w) bentazone as the sodium salt
Beret Gold	f	fludioxonil (25 g/l), seed dressing
Bravo 500	f	500g/l Chlorothalonil, 1,2-benzisothiazolin-3-one at 0.01% as a preservative
Buffalo Elite	water conditioner	ammonium sulphate (40 % w/w)
Cello	f	prothioconazole + spiroxamine + tebuconazole (100:250:100 g/l)
Cintac	h	iodosulfuron-methyl-sodium + mesosulfuron-methyl (1.0:3.0% w/w)
Claw 500	f	chlorothalonil (500 g/l)

Clayton Tebuconazole	f	250 g/l tebuconazole in an oil-in-water emulsion
Cogent (Intracrop)	ad	32.67% w/w alkoxylated alcohols and 1.0% w/w trisiloxane organosilicone copolymers
Crawler	h	carbetamide (60% w/w)
Deacon	f	200 g/l (20.0% w/w) tebuconazole
Deter	i	clothianidin (250 g/l); seed dressing
Envoy	f	epoxiconazole + pyraclostrobin (62.5:85 g/l)
Firestorm	h	diflufenican + flufenacet (100:400 g/l)
Hallmark with zeon tech	i	lambda-cyhalothrin (100 g/l)
Hurler	h	fluroxypyr (200 g/l)
Kerb Flo 500	h	500 g/litre (43.86% w/w) propyzamide
Keystone	f	epoxiconazole + isopyrazam (99:125 g/l)
Kingdom	f	boscalid + epoxiconazole (140:50 g/l)
Mobius	f	175 g/L prothioconazole and 150 g/L trifloxystrobin.
Moddus	gr	trinexapac-ethyl (250 g/l)
Pontos	h	100 g/l picolinafen and 240 g/l flufenacet.
Redigo	f	prothioconazole (100 g/l)
Redigo Deter	f	prothioconazole + clothiandin (50:250 g/l)
Redigo Pro	f	prothioconazole + tebuconazole (15:20 g/l)
Refine Max SX	h	67 g/kg metsulfuron-methyl and 333 g/kg thifensulfuron-methyl
Samurai	h	360 g/l glyphosate, present as 441g/l (35.3% w/w) of the potassium salt of glyphosate
San 703	f	375 g/l chlorothalonil and 40 g/l cyproconazole
Simba SX	h	200 g/kg metsulfuronmethyl
Sinconil	f	500 g / l chlorothalonil
Sprinter	h	700g/litre 2,4-D as the dimethylamine and the monomethylamine salts
Starane Hi-Load HL	h	480 g/litre (20.7% w/w) fluroxypyr as the 1-methyl heptyl ester (333 g/litre acid equivalent).
stefes CCC 720	gr	720 g / l chlormequat
Stomp Aqua	h	455 g/l pendimethalin

Velomax	ad	99% Modified vegetable oil, petroleum hydrocarbons, alkyl phenol ethoxlate, 1% constituents ineffective as spray adjuvants
Vortex	f	41.6 g/litre (4 % w/w) epoxiconazole and 41.6 g/litre (4 % w/w) fluxapyroxad and 61 g/litre (5.8 % w/w) pyraclostrobin.
X-Clude	water conditioner	

Machinery Referred to in the Diary Notes

Cultivators	Manufacturer	Width	Description
Plough	Kverneland	1.5 m	5 Furrow, 25 cm Furrows.
Plough	Ransome	1m	3 Furrow, 25cm Furrows
Press	Philip Watkins	4.6m	Used to level and consolidate grond after ploughing
Flexitine	Bunford	3.3 m	Used for lifting Worked ground.
Powerharrow	Kverneland	3.0 m	Used for creating seed bed.
Rotavator	Howard	1.3 m	Mainly used for BK/1 Paths.
Rotavator	Concept	1.2 m	Mainly Used for HB/2 Paths.

Drills	Manufacturer	Width	Description
Accord Combination Drill	Kverneland	3.0 m	Power-harrow Mounted Pneumatic drill with Suffolk coulters 12.5 cm apart.

Chemical Applicators	Manufacturer	Width	Description
Cascade	Horstine	12m	Tractor mounted pnuematic boom fertiliser spreader
Litetrac spreader	Litetrac	12m	Tractor mounted pnuematic boom fertiliser spreader - used for 2018 fertiliser spreading only
Muck Spreader	International	1.5 m	Trailed - FYM Applications.
Exacto-matic	Ransome, Nordsten	3.8 m	Tractor Mounted - Fert Applications.
Sprayer	Knight	24 m	Tractor Mounted - Chemical Application.
Quickpass	Yr-Crop	1.5 m	Trailed - Fert Applications.
Lowspread	Lowspread	2.76 m	Tractor Mounted - Fert Applications.

Harvesters	**Manufacturer**	**Width**	**Description**
Tucano	Claas	6 m	Commercial Combine used for harvesting discards after plot yields.
Box Mower	Wilder	1.01 m	Box Mower Mainly used for yields on PG/5.
Mower	Unifarm	1.83 m	Commercial Mower used to mow discards on PG/5.
Plot Combine	Haldrup	2m Cut	Cereal Plot Combine Harvester (used 2017 Onward).
Other	**Manufacturer**	**Width**	**Description**
Ring Rolls	Flexicoil	6m	Ring rolls for covering seed post drilling.
Topper 9	McConnell	2.72 m	Topper used for topping stubbles and grass areas.
Small Topper	Kilworth	1.1 m	Topper used with Iseki Tractor - Used for cutting Paths.
945 Conventional Baler	New Holland	-	Traditional Baler Used for baling straw samples.
Round Baler	Claas	-	Used for clearing unwanted leftover straw/grass from experiments.

Tractors	**Manufacturer**	**Weight**	**Description**
T7210	New Holland	8.1 t	Main cultivations tractor.
TL6030 Elite	New Holland	5.5 t	Sprayer tractor.
6830	John Deere	5.6 t	Drill and fertiliser application tractor.
TH4335	Iseki	1.1 t	Paths cutting tractor.
T503	Tym	2.0 t	Fertiliser applications and Rotovating.

Application code: This is used to identify the kind of application

a = application (cultivations, harvest, etc.), p = pesticide, f = fertilizer and s = seed.

19/R/BK/1 BROADBALK

Object: To study the effects of organic manures and inorganic fertilisers on continuous winter wheat and wheat in rotation. From 1968 two three-year rotations were included: potatoes, beans, winter wheat and fallow, winter wheat, winter wheat. In 1979 the first rotation was changed to fallow, potatoes, winter wheat. In 1980 the second rotation reverted to continuous winter wheat. Since 1985 part of the second rotation was added to the first to extend the rotation to fallow, potatoes, winter wheat, winter wheat, winter wheat. In 1996 the fallow was replaced by winter oats and potatoes replaced by maize in 1997. In 2018 (175th year) winter beans (Be) replaced maize on the rotational sections and the rotation was changed to wheat, wheat, oats, wheat, beans. The new rotation includes two first wheats each year. Previously, only one first wheat was included in the rotation. This change has resulted in additional harvest sampling and analysis, to include both first wheats and the beans.

2019 was the 176th year of the experiment, for previous years see 'Details' 1967 and 1973, Station Report for 1966, pp. 229-231; Station Report for 1968, Part 2; Station Report for 1982, Part 2, pp 5-44 and Yield Books for 74-18/R/BK/1.

Areas harvested [a]:

	Section	
Wheat:	0	0.00305
	1	0.00561
	4, 7 and 6	0.00463
	8, 9	0.00488
Oats:	5	0.00463
Beans:	2	0.00463

[a] The new Haldrup combine has a slightly smaller cut width (2.0m) than the previous Sampo combine (2.1m). Consequently, from 2017 cereal yields were based on a 2.0m cut width. This was also the case for cereals on the other long-term experiments. Maize yields are calculated using a row spacing of 0.7m. Maize yields for 2009-2016 were recalculated to account for the increase in row width from 0.6m to 0.7m in 2009. The corrected yields are given in the 2016 yield book.

Treatments:
In 2001 some of the treatments were changed. The treatments are now:
Whole plots

PLOT	Fertilizers and organic manures Treatments Plot	 From 2001
01 (FYM)N4	01	N4
21FYMN3	2.1	FYM N2 (1)
22FYM	2.2	FYM
03Nil	03	None
05(P)KMg	05	(P) K Mg
06N1 (P) KMg	06	N1 (P) K Mg
07N2(P)KMg	07	N2 (P) K Mg
08N3(P)KMg	08	N3 (P) K Mg
09N4(P)KMg	09	N4 (P) K Mg
10N4	10	N4
11N4PMg	11	N4 P Mg

12N1+3+1(P)K2Mg2	12	N1+3+1 (P) K2 Mg2 [(2)]
13N4PK	13	N4 P K
14N4PK*(Mg*)	14	N4 P K* (Mg*)
15N5(P)KMg	15	N5 (P) K Mg
16N6(P)KMg	16	N6 (P) K Mg
17N1+4+1PKMg	17	N1+4+1 P K Mg
18N1+2+1PKMg	18	N1+2+1 P K Mg
19N1+1+1KMg	19	N1+1+1 K Mg
20N4KMg	20	N4 K Mg

(1) FYM N3 since 2005
(2) N1+3+1 (P) KMg since 2006

Winter wheat – single N to wheat
N1, N2, N3, N4, N5, N6: 48, 96, 144, 192, 240, 288 kg N as 34.5% N; to be applied at the same time as the second dressings in the split nitrogen plots for wheat.

- split N to wheat
N1+1+1, 1+2+1 etc: Rates as above. Timings: first two weeks of March, GS31 or mid-April (whichever comes first) and GS37/mid-May.

Winter oats – single N application
½ N1, ½ N2, ½ N3, ½ N4, ½ N5, ½ N6: 24, 48, 72, 96, 120, 144 kg N as 34.5%N; applied at half the rate for wheat in a single application in mid-April; FYM applied at 35t/ha (fresh wt). Oats received no N or FYM from 1996 to 2017.

Winter Beans (Be) Non N or FYM applied.

All crops: P, K, Mg & FYM applications as shown below:-
P: 35 kg P as triple superphosphate
(P): (none since 2001), to be reviewed in 2018/19.
K: 90 kg K as potassium sulphate.
K2: 180 kg K as potassium sulphate (plus 450 kg K autumn 2000 only)
K*: 90 kg K as potassium chloride
Mg: 12 kg Mg as kieserite.
Mg2: 24 kg Mg as kieserite (plus 60kg Mg, autumn 2000 only).
(Mg*): (none since 2001), to be reviewed in 2018/19
FYM: Farmyard manure at 35 t

Previous treatment:
Whole plots

PLOT		Fertilizers and organic manures:-		
	Plot	Treatments until 1967	Treatments from 1968	Treatments from 1985 – 2000
01DN4PK	01	-	D N2 P K	D N4 P K
21DN2	21	D	D N2	D N2
22D	22	D	D	D
030	03	None	None	None
05F	05	P K Na Mg	P K (Na) Mg	PK Mg
06N1F	06	N1 P K Na Mg	N1 P K (Na) Mg	N1 P K Mg

07N2F	07	N2 P K Na Mg	N2 P K (Na) Mg	N2 P K Mg
08N3F	08	N3 P K Na Mg	N3 P K (Na) Mg	N3 P K Mg
09N4F	09	N*1 P K Na Mg	N4 P K (Na) Mg	N4 P K Mg
10N2	10	N2	N2	N2
11N2P	11	N2 P	N2 P	N2 P
12N2PNA	12	N2 P Na	N2 P Na	N2 P Na
13N2PK	13	N2 P K	N2 P K	N2 P K
14N2PKMG	14	N2 P Mg	N2 P K Mg	N2 P K Mg
15N5F	15	N2 P K Na Mg	N3 P K(Na) Mg	N5 P K Mg
16N6F	16	N*2 P K Na Mg	N2 P K (Na) Mg	N6 P K Mg
17N1+3FH	17	N2 (A)	N2 ½[P K (Na) Mg]	N1+3 ½[P K Mg] (A)+
18N0+3FH	18	P K Na Mg (A)	N2 ½[P K (Na) Mg]	N0+3 ½[P K Mg] (A)+
19(C)	19	C	C	(C) (since 1989)
20N2KMG	20	N2 K Na Mg	N2 K (Na) Mg	N2 K Mg

(A) Alternating each year

+ This change since 1980. Treatments shown are those to winter wheat; autumn N alternates. Maize received N3 ½[PK Mg] on both plots 17 and 18. These treatments shown incorrectly in 1999-2002 Yield books.

Winter oats; Nitrogen and dung were not applied 1996-2017.

N1, N2, N3, N4, N5, N6:	48, 96, 144, 192, 240, 288 kg N as sulphate of ammonia until 1967, except N* which was nitrate of soda. All as 'Nitro-Chalk' in spring from 1968 to 1985, as 34.5% N since 1986.
N0+3; N1+3:	None in autumn + 144 kg N in spring; 48 kg N in autumn + 144 kg N in spring.
P:	35 kg P as triple superphosphate in 1974 and since 1988, single superphosphate in other years
K:	90 kg K as sulphate of potash
Na:	55 kg Na as sulphate of soda
(Na):	16 kg Na as sulphate of soda until 1973
Mg:	30kg Mg annually to Plot 14 (applied at 26 kg 1990 to 2000), 35 kg Mg every third year to other plots since 1974 (applied at 30 kg in 1991, 1994, 1997 and 2000 and at 15 kg on half rate treatments). All as kieserite since 1974, previously as sulphate of magnesia annually.
D:	Farmyard manure at 35 t
(C):	Castor meal to supply 96 kg N until 1988, none since
F:	Full rate P K (Na) Mg as above
H:	Half rate of above.

Strips of sub-plots: Until 1967 wheat alone was grown on the experiment, with some bare fallowing. From 1968, the experiment was divided into 10 sections with the following cropping:

SECTION

Section	1	9	0*	8+	6**	5	3	7	4	2
Year										
1968	W	W	W	W	F	W	W	P	W	BE
1969	W	W	W	W	W	F	W	BE	P	W

Section	1	9	0*	8+	6**	5	3	7	4	2
Year										
1970	W	W	W	W	W	W	F	W	BE	P
1971	W	W	W	W	F	W	W	P	W	BE
1972	W	W	W	F	W	F	W	BE	P	W
1973	W	W	W	W	W	W	F	W	BE	P
1974	W	W	W	W	F	W	W	P	W	BE
1975	W	W	W	W	W	F	W	BE	P	W
1976	W	W	W	W	W	W	F	W	BE	P
1977	W	W	W	W	F	W	W	P	W	BE
1978	W	W	W	W	W	F	W	BE	P	W
1979	W	W	W	W	W	W	F	W	P	F
1980	W	W	W	W	W	W	W	F	W	P
1981	W	W	W	F	W	W	W	P	F	W
1982	W	W	W	W	W	W	W	W	P	F
1983	W	W	W	W	W	W	W	F	W	P
1984	W	W	W	W	W	W	W	P	F	W
1985	W	W	W	W	W	F	W	W	P	W
1986	W	W	W	W	W	P	F	W	W	W
1987	W	W	W	W	W	W	P	W	W	F
1988	W	W	W	F	W	W	W	F	W	P
1989	W	W	W	W	W	W	W	P	F	W
1990	W	W	W	W	W	F	W	W	P	W
1991	W	W	W	W	W	P	F	W	W	W
1992	W	W	W	W	W	W	P	W	W	F
1993	W	W	W	W	W	W	W	F	W	P
1994	W	W	W	F	W	W	W	P	F	W
1995	W	W	W	W	W	F	W	W	P	W
1996	W	W	W	W	W	P	O	W	W	W
1997	W	W	W	W	W	W	M	W	W	O
1998	W	W	W	W	W	W	W	O	W	M
1999	W	W	W	W	W	W	W	M	O	W
2000	W	W	W	W	W	O	W	W	M	W
2001	W	W	W	F	W	M	O	W	W	W
2002	W	W	W	W	W	W	M	W	W	O
2003	W	W	F	W	W	W	W	O	W	M
2004	W	W	F	W	W	W	W	M	O	W
2005	W	W	W	W	W	O	W	W	M	W
2006	W	W	W	W	W	M	O	W	W	W
2007	W	W	W	W	W	W	M	W	W	O
2008	W	W	W	F	W	W	W	O	W	M
2009	W	W	W	W	W	W	W	M	O	W
2010	W	W	W	W	W	O	W	W	M	W
2011	W	W	W	W	W	M	O	W	W	W
2012	W	W	W	W	W	W	M	W	W	O
2013	W	W	W	W	W	W	W	O	W	M
2014	W	W	W	W	W	W	W	M	O	W
2015[++]	W	W	W	F	W	O	W	W	M	W
2016	W	W	W	F	W	M	O	W	W	W
2017	W	W	W	W	W	W	M	W	W	O
2018	W	W	W	W	W	W	W	Be	O	W

Section	1	9	0*	8+	6**	5	3	7	4	2
Year										
2019	W	W	W	W	W	O	W	W	W	Be

W = winter wheat, O = winter oats (spring oats 2001), P = potatoes, BE = spring beans, F = fallow, M = forage maize, Be = Winter Beans

* Straw incorporated since autumn 1986. ** No sprays except weedkillers since 1985.

+ No weedkillers.

++ Spring Wheat in 2015

NOTES:

(1) For a fuller record of treatments see 'Details' etc.

(2) From autumn 1975 to autumn 1986, chalk was applied at 2.9t each autumn to all plots in sets of Sections on a three-year cycle. Year 1: Sections 1, 2, 3. Year 2: Sections 6, 7, 8, 9. Year 3: Sections 0, 4, 5. From autumn 1988 until autumn 1992 a five-year cycle was used. Year 1: Sections 1, 3. Year 2: Sections 2, 8. Year 3: Sections 7, 9. Year 4: Sections 4, 6. Year 5: Sections 0, 5 (omitted). No chalk was applied after autumn 1991 until autumn 2007 when differential amounts were applied to selected plots (see "Results 2008"). Chalk was applied again to selected plots in autumn 2013, see 14/R/BK/1 diary information.

(3) In 2003 and 2004 section 0 was used for an experiment (CS/595) investigating different herbicides to control *Equisetum arvense*.

(4) In 2013 the wheat variety changed from Hereward to Crusoe, but it was sown very late (22nd February 2013) because of the very wet autumn and winter of 2012-13.

(5) Spring wheat (var Mulika) and winter oats (var Gerald) were sown in March 2015, instead of in autumn/winter 2014, because the very wet soil conditions in autumn 2014 prevented sowing of a winter crop. The whole site was spring-tine cultivated in March 2015 instead of being ploughed. Section 8 was left in bare fallow in 2015 & 2016 and had two in-season cultivations (inversion ploughing) each year to control weeds.

(6) In 2018 winter beans (Be) replaced maize on the rotational sections to give a five year rotation of wheat, wheat, oats, wheat, beans. Details of changes to N fertilizer and FYM applications are given on p2.

19/R/BK/1 Experimental Diary:

Date		Application	Rate	Unit
All Sections				
12/09/2018	f	Applied TSP Treatments - to strips 11, 13, 14, 17 + 18	171	kg/ha
12/09/2018	f	Applied MOP Treatments - to strip 14	181	kg/ha
13/09/2018	f	Applied Chalk - to plots 2.10, 070, 080, 100, 110, 140, 160, 081, 101, 111, 151, 012, 072, 082, 152, 153, 134, 144, 154, 075, 085, 105, 115, 125, 135, 145, 155, 066, 076, 086, 126, 136, 156, 196, 017, 067, 077, 097, 107, 117, 127, 137, 147, 157, 177, 058, 068, 078, 098 ,138, 148, 168, 178, 188, 069, 099, 109, 139, 149, 169, 179, 189, 199	2	t /ha
13/09/2018	f	Applied Chalk - to plots 150, 161, 195, 106, 116, 087, 167, 088, 108, 118, 128, 158, 198, 089, 119, 129, 159	4	t /ha

13/09/2018	p	Sprayed Buffalo Elite	1	lt/ha
13/09/2018	p	Sprayed Buffalo Samurai	2.5	lt/ha
18/09/2018	a	Ploughing Field	-	-
19/09/2018	a	Cultipressed Ploughing	-	-
27/09/2018	a	Watkins Pressed All Ploughing	-	-
04/10/2018	a	Ring Rolled Wheat Drilling	-	-
26/03/2019	a	Flexitined surrounds	-	-
11/04/2019	a	Cut Paths	-	-
29/04/2019	a	Cut Paths	-	-
13/05/2019	a	Topped paths - Section 8	-	-
20/05/2019	f	applied Kieserite - to strips 20, 19, 18, 17, 16, 15, 12, 11, 9, 8, 7, 6 + 5	80	kg/ha
21/05/2019	f	Applied SOP - to strips - 20, 19, 18, 17, 16, 15, 13, 12, 9, 8, 7, 6 + 5	217	kg/ha
25/06/2019	a	Rotavated all paths	-	-
11/07/2019	a	Removed Wild Oats from plots	22	plants
29/07/2019	a	Topped plot ends	-	-
06/09/2019	a	Straw weights	-	-
07/09/2019	a	Harvested Commercial Area	-	-
09/09/2019	a	Bale surplus straw from plots	-	-
12/09/2019	a	Rolled by flexicoil	-	-

W WHEAT

17/09/2018	f	Applied FYM - to Strip 2.1 and 2.2 excluding Section 2	35	t /ha
03/10/2018	s	Drilled Zyatt, trt. Beret Gold/Deter	350	seed/m^2
05/10/2018	p	Sprayed Pontos	1	lt/ha
05/10/2018	p	Sprayed Firestorm	300	ml/ha
05/10/2018	p	Sprayed Velomax	400	ml/ha
26/11/2018	p	sprayed Hallmark - not Section 2	5	ml/ha
21/03/2019	p	Sprayed X-Clude - to Sections 0 1 3 4 6 7 + 9	250	ml/ha
21/03/2019	p	Sprayed Cintac - to Sections 0 1 3 4 6 7 + 9	500	rm/ha
21/03/2019	p	Sprayed Cogent - to Sections 0 1 3 4 6 7 + 9	1	lt/ha
25/03/2019	f	Applied Nitram (1st split) - to strips 12 17 18 + 19	139	kg/ha
01/04/2019	p	Sprayed stefes720 - Section 6	1.25	lt/ha
01/04/2019	p	Sprayed Moddus - Section 6	150	ml/ha
01/04/2019	p	Sprayed Artemis - not Sections 6 or 8	1	lt/ha
01/04/2019	p	Sprayed Stefes720 - not Sections 6 or 8	1.25	lt/ha
01/04/2019	p	Sprayed Moddus - not Sections 6 or 8	150	ml/ha
01/04/2019	p	Sprayed Bravo500 - not Sections 6 or 8	1	lt/ha
12/04/2019	f	Applied Nitram - to strips 15	696	kg/ha
12/04/2019	f	Applied Nitram - to strips 16	835	kg/ha
12/04/2019	f	Applied Nitram (2nd split) - to strips 19	139	kg/ha
12/04/2019	f	Applied Nitram (2nd split) - to strips 18, 7	278	kg/ha
12/04/2019	f	Applied Nitram - to strips 12, 8, 2.1	417	kg/ha
12/04/2019	f	Applied Nitram - to strips 20, 17, 14, 13, 11, 10, 9	556	kg/ha
09/05/2019	p	Sprayed SimbaSX - Sections 0, 1, 3, 4, 7 + 9	30	gm/ha
09/05/2019	p	Sprayed Keystone - Sections 0, 1, 3, 4, 7 + 9	800	ml/ha

09/05/2019	p	Sprayed Sinconil - Sections 0, 1, 3, 4, 7 + 9	1	lt/ha
13/05/2019	f	Applied Nitram (3rd split) - to strips 19, 18, 17 + 12	139	kg/ha
27/06/2019	p	Sprayed Clayton Tebuconazole - Sections 0, 1, 3, 4, 7, 8 + 9	500	ml/ha
27/06/2019	p	Sprayed Vortex - Sections 0, 1, 3, 4, 7, 8 + 9	1.25	lt/ha
26/08/2019	a	Harvested All Plots - Sections 0, 1, 3, 4, 5, 6, 7, 8, 9	-	-

W OATS

17/09/2018	f	Applied FYM - to Strip 2.1 and 2.2 excluding Section 2	35	t /ha
03/10/2018	s	Drilled Mascani, trt. beret gold - Section 5	350	seed/m^2
26/11/2018	p	Sprayed Hallmark - not Section 2	5	ml/ha
15/04/2019	f	Applied Nitram - Strip 6 - section 5 only (0.5 normal rate)	35	kg/ha
15/04/2019	f	Applied Nitram - Strip 7 - section 5 only (0.5 normal rate)	69.5	kg/ha
15/04/2019	f	Applied Nitram - Strip 2.1, 8 - section 5 only (0.5 normal rate)	104.5	kg/ha
15/04/2019	f	Applied Nitram - Strip 9, 10, 11, 13, 14, 18 - section 5 only (0.5 normal rate)	139	kg/ha
15/04/2019	f	Applied Nitram - Strip 12, 15 - section 5 only (0.5 normal rate)	174	kg/ha
15/04/2019	f	Applied Nitram - Strip 16, 17 - section 5 only (0.5 normal rate)	208.5	kg/ha
16/05/2019	p	Sprayed Refine Max - Section 5	75	gm/ha
16/05/2019	p	Sprayed Stefes 720 - Section 5	2	lt/ha
16/05/2019	p	Sprayed Starane Hi - Section 5	400	ml/ha
16/05/2019	p	Sprayed Envoy - Section 5	1	lt/ha
26/08/2019	a	Harvested All Plots - Sections 0, 1, 3, 4, 5, 6, 7, 8, 9	-	-
10/09/2019	a	Harvested Commercial Area - Section 5	-	-

W BEANS

03/10/2018	s	Drilled Tundra - Section 2	35	seed/m^2
10/10/2018	p	Sprayed Kerb Flo 500 - Section 2	1.7	lt/ha
10/10/2018	p	Sprayed Stomp Aqua - Section 2	2.9	lt/ha
21/02/2019	p	Sprayed Crawler - Section 2	3	kg/ha
13/05/2019	p	Sprayed SAN703 - Section 2	1.5	lt/ha
13/05/2019	p	Sprayed Hallmark - Section 2	75	ml/ha
02/07/2019	p	Sprayed Aphox - Section 2	280	gm/ha
02/07/2019	p	Sprayed San703 - Section 2	2	lt/ha
30/08/2019	a	Harvested all plots - Section 2	-	-

WILDERNESS

07/01/2019	a	Topped middle and northern sections	-	-
01/04/2019	a	Topped middle block	-	-

NOTE: Samples of grain and straw were taken for chemical analysis. Unground grain and straw samples from selected treatments were archived.

YIELDS

WINTER WHEAT

Grain Tonnes/Hectare (85% DM)

Tables of means

SECTION PLOT	4/W1	7/W1	3/W2	6/W42	0/W15	1/W53	9/W61	8/W3	Mean
01(FYM)N4	-	10.42	10.35	7.58	-	-	-	-	9.45
21FYMN3	11.24	11.43	12.04	8.12	9.97	11.43	10.13	1.82	9.52
22FYM	6.46	9.59	8.05	7.11	5.87	7.13	6.77	2.51	6.69
03Nil	1.15	1.70	1.39	1.20	0.94	1.07	0.54	1.11	1.14
05(P)KMg	1.57	3.76	1.77	1.35	1.63	1.50	1.39	1.56	1.82
06N1(P)KMg	3.95	5.80	4.29	2.73	3.56	3.30	3.26	1.66	3.57
07N2(P)KMg	6.52	7.14	6.10	4.04	3.63	4.29	4.61	1.91	4.78
08N3(P)KMg	7.68	8.10	7.11	4.28	5.73	4.96	5.36	2.67	5.74
09N4(P)KMg	8.91	9.79	8.95	5.66	6.98	6.95	6.23	2.11	6.95
10N4	4.20	6.97	5.27	2.21	1.92	1.92	1.82	1.05	3.17
11N4PMg	7.97	8.54	6.99	4.15	7.52	6.10	6.11	1.76	6.14
12N1+3+1(P)KMg	9.67	9.87	9.51	5.91	8.24	7.99	8.11	1.96	7.66
13N4PK	9.09	9.28	8.53	5.87	7.18	6.09	7.35	2.18	6.94
14N4PK*(Mg*)	8.77	8.95	8.20	6.82	6.35	6.76	7.31	3.97	7.14
15N5(P)KMg	10.65	9.52	9.85	6.61	8.22	7.74	6.84	1.93	7.67
16N6(P)KMg	8.04	9.12	7.97	7.60	8.86	8.09	7.16	1.80	7.33
17N1+4+1PKMg	10.46	10.91	10.71	7.89	9.55	9.32	9.36	0.76	8.62
18N1+2+1PKMg	8.90	10.2	9.40	7.29	7.81	7.12	7.92	2.21	7.61
19N1+1+1KMg	7.40	9.02	7.55	6.23	6.84	5.50	6.93	2.81	6.54
20N4KMg	-	-	-	-	1.94	1.01	-	-	1.48
Mean	7.37	8.43	7.58	5.40	5.93	5.70	5.96	1.99	6.06
Grain Mean DM%	90.20								

Straw Tonnes/Hectare

Tables of means

SECTION PLOT	4/W1	7/W1	3/W2	6/W42	0/W15	1/W53	9/W61	8/W3	Mean
01(FYM)N4	2.98	3.44	-	-	-	-	-	-	3.21
21FYMN3	4.10	5.40	-	-	-	5.22	-	5.08	4.95
22FYM	1.84	3.74	-	-	-	3.16	-	4.00	3.18
03Nil	0.06	0.04	-	-	-	0.14	-	0.01	0.06
05(P)KMg	0.06	0.55	-	-	-	0.33	-	1.61	0.64
06N1(P)KMg	0.56	1.10	-	-	-	0.81	-	1.74	1.05
07N2(P)KMg	1.00	1.13	-	-	-	1.05	-	1.72	1.22
08N3(P)KMg	1.10	1.59	-	-	-	1.53	-	2.40	1.66
09N4(P)KMg	1.56	2.55	-	-	-	1.88	-	3.02	2.25
10N4	0.56	1.20	-	-	-	0.70	-	0.53	0.75
11N4PMg	1.47	1.72	-	-	-	1.62	-	2.60	1.85
12N1+3+1(P)KMg	2.30	2.88	-	-	-	2.74	-	3.64	2.89
13N4PK	1.77	1.87	-	-	-	1.64	-	2.79	2.02
14N4PK-(Mg-)	1.64	1.91	-	-	-	2.15	-	2.75	2.11
15N5(P)KMg	2.86	1.88	-	-	-	2.61	-	2.99	2.59
16N6(P)KMg	2.33	2.62	-	-	-	2.85	-	3.44	2.81
17N1+4+1PKMg	2.63	2.69	-	-	-	3.35	-	3.15	2.96
18N1+2+1PKMg	1.65	2.78	-	-	-	1.53	-	3.61	2.39
19N1+1+1KMg	1.78	2.51	-	-	-	1.40	-	2.93	2.16
20N4KMg	-	-	-	-	-	0.11	-	-	0.11
Mean	1.70	2.19	-	-	-	1.83	-	2.67	2.09

Straw Mean DM% 90.10

WINTER OAT

Tonnes/Hectare (85% DM)

Table of means

Plot	Treatment	Grain	Straw
15	01 (FYM) 1/2N4	7.69	3.78
215	21 FYM 1/2N3	7.52	5.67
225	22 FYM	5.67	2.85
35	03 Nil	1.41	0.23
55	05 (P)KMg	1.51	0.30
65	06 1/2N1 (P)KMg	3.23	0.43
75	07 1/2N2 (P)KMg	4.67	0.94
85	08 1/2N3 (P)KMg	6.09	1.52
95	09 1/2N4 (P)KMg	7.59	2.40
105	10 1/2N4	6.01	1.39
115	11 1/2N4 PMg	8.05	2.92
125	12 1/2N5 (P)KMg	8.10	2.97
135	13 1/2N4 PK	7.47	2.50

145	14 1/2N4 PK*(Mg*)	7.10	2.25
155	15 1/2N5 (P)KMg	8.51	3.29
165	16 1/2 N6 (P)KMg	8.60	3.68
175	17 1/2N6 PKMg	8.62	3.79
185	18 1/2N4 PKMg	7.29	2.22
195	19 1/2N3 KMg	6.39	1.85
	Mean	6.40	2.37
Plot Area Harvested	0.00463		

WINTER BEANS

TONNES/HECTARE (85% DM)

Tables of means

Plot	Treatment	Grain	Straw
12	01 (FYM) [N4]	3.12	3.03
212	21 [FYMN3]	3.08	5.17
222	22 [FYM]	2.99	5.25
32	03 Nil	0.67	0.07
52	05 (P)KMg	2.90	2.02
62	06 [N1] (P)KMg	3.64	2.79
72	07 [N2] (P)KMg	3.72	2.65
82	08 [N3] (P)KMg	3.19	2.84
92	09 [N4] (P)KMg	2.80	2.12
102	10 [N4]	0.40	0.06
112	11 [N4] PMg	0.03	0.00
122	12 [N1+3+1] (P)KMg	3.05	2.52
132	13 [N4] PK	3.33	3.01
142	14 [N4] PK*(Mg*)	2.68	2.75
152	15 [N5] (P)KMg	3.37	2.74
162	16 [N6] (P)KMg	3.40	2.83
172	17 [N1+4+1] PKMg	2.96	3.39
182	18 [N1+2+1] PKMg	3.37	2.66
192	19 [N1+1+1] KMg	2.03	1.73
	MEAN	2.67	2.64
Mean DM%		87.10	94.00
PLOT AREA HARVESTED		0.00453	

Section 8 Wheat Yields: Clean Grain (2.0-3.5mm), Tonnes/Hectare, after removing weed seed

YEAR	2019
SECTION	8/W3
PLOT	
2.1 FYMN3	1.70
2.2 FYM	2.35
03 Nil	1.03
05 (P)KMg	1.24
06 N1(P)KMg	1.45
07 N2(P)KMg	1.76
08 N3(P)KMg	2.49
09 N4(P)KMg	1.89
10 N4	0.95
11 N4PMg	1.62
12 N1+3+1(P)K2Mg2	1.77
13 N4PK	1.99
14 N4PK*(Mg*)	3.62
15 N5(P)KMg	1.72
16 N6(P)KMg	1.65
17 N1+4+1PKMg	0.65
18 N1+2+1PKMg	2.06
19 N1+1+1KMg	2.67
Mean	1.81

Note: All clean grain yields for section 8 are reported for the 2 - 3.5mm grain size fraction, excluding grain <2mm, as was the practice prior to 2012.

19/R/HB/2 HOOS BARLEY (Hoosfield)

Object: To study the effects of organic manures and inorganic fertilizers on continuous spring barley. From 1968 to 1978 a rotation of potatoes, beans and spring barley was practised on parts of the experiment. The rotation was discontinued in 1979 and the whole experiment reverted to continuous spring barley. The experiment was modified for 2003. The main plots continue as previously. The Silicate Test plots continue but are not split to test rates of N (basal N is applied). The remaining plots are to be used to study the effect on yield of P residues, (basal N applied).

The 168th year, spring barley.

For previous years see 'Details' 1967 and 1973, Station Report for 1966 and Yield Books for 74-18/R/HB/2.

Main plots

Treatments:

Whole plots

MANURE		**Fertilizers and Organic Manures:-**		
	Plot	Form of N 1852-1966	Additional treatments 1852-2002	Treatments since 2003
---	11	None	-	-
-P-	21	None	P	(P)
--K	31	None	K (Na) Mg	K(Mg)
-PK	41	None	PK (Na) Mg	(P) K (Mg)
A--	12	A	-	-
AP-	22	A	P	(P)
A-K	32	A	K (Na) Mg	K(Mg)
APK	42	A	PK (Na) Mg	(P) K (Mg)
D1852	72	None	D	D
(D)	71	None	(D)	(D)
(A)	62	None	(Ashes)	(Ashes)
-	61	None	-	-
D2001 [a]	73[a]	-	D	D
P2KMg [a]	63 [a]	-	P2KMg	P2KMg

[a] Plots 63 and 73 started in 2001

Form of N: A, sulphate of ammonia to supply 48kg N
P: 35 kg P as triple superphosphate in 1974 and from 1988 to 2002, single superphosphate in other years
(P): (none), P application to be reviewed for 2018
P2: 44kg P as triple superphosphate
K: 90 kg K as sulphate of potash
(Na): (none), 16 kg Na as sulphate of soda until 1973
Mg: 35kg Mg as kieserite every third year since 1974 (applied at 30 kg in 1992, 1995 and 1998) (sulphate of magnesia annually until 1973). Annually to new plot 63.
(Mg): (none), Mg application to be reviewed for 2021

D1852: Farmyard manure at 35t since 1852
D2001: Farmyard manure at 35t since 2001
(D): Farmyard manure 1852 – 1871 only
(Ashes): Weed ash 1852-1916, furnace ash 1917-1932, none since

Sub-plots

(2) N Nitrogen fertilizer (kg N), as 'Nitro-Chalk', since 1968 (cumulative N applications until 1973, on a cyclic system since 1974):

0
48
96
144

Silicate Test plots

Treatments:

Whole plots

MANURE	**Plot**	**Fertilizers:-** Additional treatment 1852-1979	Changes since 1980	Treatments since 2003
N----	131	-	-	N3
NP---	231	P	-	N3 (P)
N-K--	331	K(Na)Mg	-	N3 K(Mg)
NPK--	431	PK(Na)Mg	-	N3(P)K(Mg)
N—S-	134	Si	Si omitted	N3 (Si)
NP-S-	234	P Si	Si omitted	N3(P) (Si)
N-KS-	334	K(Na)MgSi	Si omitted	N3 K(Mg)(Si)
NPKS-	434	PK(Na)MgSi	Si omitted	N3(P)K(Mg)(Si)
N---S	132	-	Si added	N3 Si
NP--S	232	P	Si added	N3(P) Si
N-K-S	332	K(Na)Mg	Si added	N3 K(Mg) Si
NPK-S	432	PK(Na)Mg	Si added	N3(P)K(Mg) Si
N--SS	133	Si	-	N3 Si
NP-SS	233	P Si	-	N3(P) Si
N-KSS	333	K(Na)MgSi	-	N3 K(Mg) Si
NPKSS	433	PK(Na)MgSi	-	N3(P)K(Mg) Si

N: From 1852-1966 whole plots received 48kg N as nitrate of soda. Between 1968-2002 whole plots were split to test 4 rates of N as "Nitro-chalk" (cumulative applications until 1973, on a cyclic system from 1974).
N3: Basal N, 144kg as "Nitro-chalk" since 2003
Si: Silicate of soda at 450kg (Note: S also refers to silicate of soda)
(Si): Silicate of soda omitted since 1980
P, (P), K, Mg, (Mg), (Na): as above

Phosphorus Test plots

Treatments:

Since 2003 the remaining plots [ex-Castor meal (plots 14, 24, 34 & 44) and those testing combinations of NPK with and without Mg (plots 55, 56, 57 & 58)] have been used to study the effect of P residues on yield. Previous treatments have resulted in different levels of available P in the soil. Large dressings of K were applied to some plots to increase levels of exchangeable K in the soil such that K should not limit yield; plots 141 and 241 were sacrificed and used as discard areas so that the K application did not encroach on adjacent no K plots on the Silicate Test. Other plots received the normal rate of K. The level of exchangeable Mg in the soil is such that Mg should not limit yield; the need to apply Mg was reviewed for 2019.

Whole plots

Manure

Plot	Treatment since 2003
142	N3K*
143	N3K*
144	N3K*
242	N3K*
243	N3K*
244	N3K*
341	N3K
342	N3K
343	N3K
344	N3K
441	N3K
442	N3K
443	N3K
444	N3K
551	N3K
552	N3K
561	N3K
562	N3K
571	N3K*
572	N3K*
581	N3K*
582	N3K*

N3: Basal N, 144kg as “Nitro-chalk”
K: 90kg K as sulphate of potash
K*: 450kg K as sulphate of potash
In 2005 the extra dressings of K (i.e. K*) was stopped and all of the P test plots reverted to K

Experimental Diary

Date		Application	Rate	Units
06/09/2018	f	Applied Chalk to plots 711-734, 411-551, 611-634, 311-561, 241-571, 141-581	4	t/ha
08/11/2018	f	Applied TSP - to plots 631-634	215	kg/ha
08/11/2018	f	Applied SOP - to plots 631-634, 411-551, 311-561, 241-571, 141-581	217	kg/ha
08/11/2018	f	Applied Kieserite - to plots 631-636	233	kg/ha
12/11/2018	p	Sprayed Buffalo Elite	1	lt/ha
12/11/2018	p	Sprayed Samurai	4	t/ha
15/11/2018	f	Applied Silicate of Soda - to plots 433-133, 432-132	450	kg/ha
16/11/2018	f	Applied FYM - to plots 721-734	35	t/ha
20/11/2018	a	Ploughed, thrown North	-	-
21/02/2019	a	Cousin cultivated trial and surrounds	-	-
22/02/2019	a	Ring Rolled All New Drilling	-	-
22/02/2019	s	Drilled KWS Irina,trt Redigo Pro	350	seed/m^2
11/04/2019	a	Rotavated Paths	-	-
18/04/2019	f	Applied N as Nitro-Chalk by hand - to plots 114,122, 213, 224, 312, 323, 411, 424, 612, 622, 632, 714, 723, 733	48	kg/ha
18/04/2019	f	Applied N as Nitro-Chalk by hand - to plots 111, 121, 214, 221, 311, 322, 413, 423, 614, 623, 633, 713, 724, 734	96	kg/ha
18/04/2019	f	Applied N as Nitro-Chalk by hand - to plots 113, 124, 211, 222, 313, 321, 412, 421, 611, 621, 631, 712, 721, 732	144	kg/ha
30/04/2019	p	Sprayed Hallmark	50	ml/ha
15/05/2019	p	Sprayed Refine Max	75	g/ha
15/05/2019	p	Sprayed Kingdom	1.5	lt/ha
15/05/2019	p	Sprayed Claw 500	1	lt/ha
15/05/2019	p	Sprayed Starane Hi	400	ml/ha
16/05/2019	f	Applied Nitram - to old series 5, c, aa - not plots 6, 7	417	kg/ha
02/07/2019	p	Sprayed Mobius	400	ml/ha
15/07/2019	a	Pulled Oats	13	plants
06/09/2019	a	Harvested All Plots	-	-
09/09/2019	a	Bale surplus straw from plots	-	-
10/09/2019	a	Straw Weights recorded in grams for all main plots	-	-

Yields

Main Plots

Grain Yield, tonnes/hectare

Table of means

N	0	48	96	144	Mean
MANURE					
---	1.86	2.26	3.35	2.21	2.42
-P-	2.31	3.33	4.23	4.94	3.70
--K	3.08	4.00	4.62	3.88	3.90
-PK	2.99	5.19	6.15	5.94	5.07
A--	1.70	2.34	2.42	2.86	2.33
AP-	2.71	4.10	4.32	4.23	3.84
A-K	2.78	3.36	3.78	3.62	3.38
APK	3.34	4.99	6.14	5.86	5.08
FYM1852onwards	8.35	9.15	8.54	8.76	8.70
FYM1852-1871	2.95	5.78	5.81	5.06	4.90
(A)	3.37	3.58	4.18	3.82	3.74
-	2.45	3.54	4.04	3.78	3.45
FYM2001onwards	7.39	7.84	7.16	7.85	7.56
P2K	2.81	5.35	5.76	6.56	5.12
Mean	3.43	4.63	5.04	4.96	4.51
Grain mean DM%	87.00				

Straw Yield, tonnes/hectare

Table of means

N MANURE	0	48	96	144	Mean
---	0.09	0.54	0.71	0.66	0.50
-P-	0.46	0.66	1.19	1.37	0.92
--K	0.56	0.97	1.42	1.10	1.01
-PK	0.70	1.65	2.14	2.21	1.68
A--	0.36	0.59	0.58	0.55	0.52
AP-	0.53	1.00	1.28	1.10	0.98
A-K	0.69	0.69	0.90	1.01	0.82
APK	0.84	1.86	2.13	1.60	1.61
FYM1852onwards	3.28	3.80	3.80	3.18	3.51
FYM1852-1871	0.93	1.77	0.99	1.35	1.26
(A)	0.95	0.96	1.15	0.68	0.93
-	0.20	0.98	1.04	0.47	0.67
FYM2001onwards	2.54	2.61	2.94	3.40	2.87
P2K	0.84	1.82	1.62	2.28	1.64
Mean	0.93	1.42	1.56	1.50	1.35

Straw mean DM%	84.70	
Plot Area	0.00244	0.00183

PHOSPHATE PLOTS

Grain Yield, tonnes/hectare

Tables of means

PLOTS

142	4.07
143	4.43
144	3.81
242	4.56
243	4.62
244	4.85
341	4.33

342	4.50
343	5.38
344	5.44
441	3.71
442	4.96
443	5.55
444	5.60
551	6.09
552	6.15
561	5.80
562	6.09
571	5.25
572	5.68
581	2.56
582	2.46
Mean	4.81
Grain Mean DM%	85.2
Plot area Harvested	0.00244

SILICATE PLOTS

Grain Yield, tonnes/hectare

Tables of means

PK	N3--	N3P-	N3-K	N3PK	Mean
Silicate					
(-)-	3.21	3.96	3.18	5.32	3.92
Si)-	3.57	4.41	4.78	4.93	4.42
(-)Si	4.36	4.87	4.89	5.38	4.88
(Si)Si	4.28	5.03	5.05	6.03	5.10
Mean	3.85	4.57	4.48	5.41	4.58
Grain Mean DM%	85.2				
Plot area harvested	0.00244				

19/R/WF/3 WHEAT AND FALLOW (Hoosfield)

Object: To maintain a low plant available P site – Hoosfield.

Whole plot dimensions: 9 x 211

Treatments:

Two plots, one sown to winter wheat, one fallow; alternating in successive years. From 2016 this experiment was converted to continuous wheat on both plots, with no yields or samples taken at harvest. For previous years see 'Details' 1967, 1973 and Yield Books for 74-18/R/WF/3.

Experimental Diary

Date		Application	Rate	Units
06/09/2018	p	Sprayed Buffalo Elite	1	lt/ha
06/09/2018	p	Sprayed Samurai	2.5	lt/ha
20/09/2018	a	Ploughed Trials and Surrounds	-	-
05/10/2018	s	Drilled Crusoe, trt. Beret Gold/Deter	350	seed/m^2
05/10/2018	p	Sprayed Pontos - Winter Wheat	1	lt/ha
05/10/2018	p	Sprayed Firestorm - Winter Wheat	300	ml/ha
05/10/2018	p	Sprayed Velomax - Winter Wheat	400	l/ ha
05/10/2018	a	Flexicoil Rolled new drilling	-	-
21/11/2018	p	Sprayed Hallmark	50	ml/ha
27/03/2019	p	Sprayed Deacon	625	ml/ha
27/03/2019	p	Sprayed Stefes720	1.25	lt/ha
27/03/2019	p	Sprayed Moddus	150	ml/ha
27/03/2019	p	Sprayed Bravo500	1	lt/ha
10/04/2019	f	Applied Nitram	145	kg/ha
06/06/2019	p	Sprayed Clayton Tebuconazole	500	ml/ha
06/06/2019	p	Sprayed Vortex	1.25	lt/ha
21/08/2019	a	Bale Straw (discard areas)	-	-
07/09/2019	a	Harvest	-	-

19/R/EX/4 EXHAUSTION LAND (Hoosfield)

Object: To study the residual effects of manures applied 1856 - 1901, and of additional phosphate applied since 1986 (P test) and of additional potassium since 2007 (K test); on the yield of continuous spring barley up to 1991, winter wheat since – Hoosfield.

The 164th year, winter wheat.

For previous years see 'Details' 1977, 1973 and Yield Books for 74-18/R/EX/4

Treatments: All combinations of:

Whole plots (P test)

1. **OLD RES** Residues of manures applied annually 1876 – 1901:

Main plot

01	O	None
03	D	Farmyard manure at 35 t
05	N	96 kg N as ammonium salts
09	P	34 kg P as superphosphate
07	NPKNaMg	N and P as above plus 137 kg K as sulphate of potash, 16 kg Na as sulphate of soda, 11 kg Mg as sulphate of magnesia

2. P Maintenance P (20 kg P) applied annually from 2000

to maintain existing levels of available P In the soil. In 2009 maintenance P applications were changed from 20 kg P/ha to 15 kg P/ha. This was not recorded in the yield books for 2009-13. (P1) (P2) and (P3) are residues of P applied annually. From 2016 onward P was withheld from the P(P1) sub-plots.

1986–1992:

	2016-Present	2009-2015	2000-08	1986-92
O	None	None	None	None
P (P1)	None	15 kg P	20 kg P	44 kg P
P (P2)	15 kg P	15 kg P	20 kg P	87 kg P
P (P3)	15 kg P	15 kg P	20 kg P	131 kg P

NOTE: P treatments were applied at 61.5 kg P in error in 2000.

Plus

Whole plots (K test, previously N test until 1991)

1. **OLD RES** Residues of manures applied annually 1876 – 1901:

Main Plot

02	O	None
04	D	Farmyard manure at 35 t
06	N*	96 kg N as nitrate of soda
10	PK	34 kg P as superphosphate, 137 kg K as sulphate of potash
08	N*PK	N, P and K as above

2. K Potassium applied annually from 2007 as muriate of potash

O	None (2 sub-plots within each treatment strip)
K1	75 kg K2O (62.2 kg K)
K2	150 kg K2O (124.5 kg K)

Whole plots

Nitrogen: 50 kg N as ammonium sulphate (to supply sufficient S) during first two weeks in March, 200 kg N as ammonium nitrate at GS31/mid-April (whichever comes first) and 50 kg N as ammonium nitrate at GS37 (not later than mid-May).

Experimental Diary

Date		Application	Rate	Unit
06/09/2018	p	Sprayed Buffalo Elite	1	lt/ha
06/09/2018	p	Sprayed Samurai	2.5	lt/ha
07/09/2018	f	Applied Chalk - to plots 011, 012, 013, 023, 024, 031,034, 041, 043, 052, 054, 081, 084, 091, 104	2	t/ha
07/09/2018	f	Applied Chalk - to plots 022, 044, 053, 061, 062, 063, 064, 071, 073, 074, 082, 083, 101, 102, 103	4	t/ha
19/09/2018	f	Applied TSP - to all P plots	75	kg/ha
19/09/2018	f	Applied MOP - to plots 023, 043, 063, 083, 103	125	kg/ha
19/09/2018	f	Applied MOP - to plots 011-014, 024, 031-034, 044, 051-054, 064, 071-074, 084, 091-094, 104	250	kg/ha
20/09/2018	a	Ploughed Trials and Surrounds - thrown North	-	-
29/09/2018	a	Watkins Pressed All Ploughing	-	-
05/10/2018	s	Drilled Crusoe, trt. Beret Gold/Deter	350	sm^2
05/10/2018	p	Sprayed Pontos - Winter Wheat	1	lt/ha
05/10/2018	p	Sprayed Firestorm - Winter Wheat	300	ml/ha
05/10/2018	p	Sprayed Velomax - Winter Wheat	400	ml/ha
05/10/2018	a	Flexicoil Rolled new drilling	-	-
21/11/2018	p	Sprayed Hallmark	50	ml/ha
26/03/2019	f	Applied Ammonia Sulphate (21%N, 60% SO_3)	238	kg/ha
27/03/2019	p	Sprayed Deacon	625	ml/ha
27/03/2019	p	Sprayed Stefes720	1.25	lt/ha
27/03/2019	p	Sprayed Moddus	150	ml/ha
27/03/2019	p	Sprayed Bravo500	1	lt/ha
10/04/2019	f	Applied Nitram (34.5%)	580	kg/ha
13/05/2019	f	Applied Nitram (34.5%)	145	kg/ha

21/05/2019	f	Applied Kieserite to all plots	80	kg/ha
06/06/2019	p	Sprayed Clayton Tebuconazole	500	ml/ha
06/06/2019	p	Sprayed Vortex	1.25	lt/ha
29/07/2019	a	Topped plot ends	-	-
05/09/2019	a	Harvested all plots	-	-
06/09/2019	a	Straw weights	-	-
07/09/2019	a	Harvested Commercial Area	-	-

Yields

P TEST
Grain Yield, tonnes/hectare

Tables of means

P_RES OLD_RES	O	(P1)	(P2)	(P3)	Mean
O	1.07	4.25	6.64	7.48	4.86
D	2.47	7.33	9.24	8.97	7.00
N	1.30	4.16	6.81	7.91	5.05
P	2.42	7.15	8.89	8.81	6.82
NPKNAMG	2.26	6.02	8.21	9.00	6.37
Mean	1.90	5.78	7.96	8.43	6.02

Grain mean DM% 86.3

Straw Yield, tonnes/hectare

Tables of means

P_RES OLD_RES	O	(P1)	(P2)	(P3)	Mean
O	0.48	1.59	2.64	2.72	1.86
D	1.68	3.07	4.40	3.53	3.17
N	0.79	2.35	2.64	2.81	2.15
P	1.09	2.17	2.99	3.05	2.33
NPKNAMG	1.52	2.26	3.20	3.53	2.63
Mean	1.11	2.29	3.17	3.13	2.43

Straw mean DM% 95.7

Plot area harvested 0.00512.

K TEST

Grain Yield, tonnes/hectare

Tables of means

K_Test	K0	K1	K2	Mean
OLD_RES				
O	6.29	8.30	8.55	7.36
D	6.83	9.44	8.98	8.02
N*	5.52	8.32	8.24	6.90
PK	8.66	9.13	9.57	9.01
N*PK	7.65	8.87	9.49	8.41
Mean	6.99	8.81	8.96	7.94

Grain mean DM% 86.5

Straw Yield, tonnes/hectare

Tables of means

K_Test	K0	K1	K2	Mean
OLD_RES				
O	1.98	2.83	3.24	2.51
D	2.31	3.94	3.85	3.10
N*	1.90	2.97	2.99	2.44
PK	2.86	3.11	3.27	3.03
N*PK	2.49	3.16	4.08	3.06
Mean	2.31	3.20	3.49	2.83

Straw mean DM% 95.40

Plot area harvested 0.00512

19/R/PG/5 PARK GRASS

Object: To study the effects of organic manures and inorganic fertilisers and lime on old grass for hay.

The 164th year, hay.
For previous years see 'Details' 1977 and 1973 and Yield Books for 74-18/R/PG/5.

Treatments: Combinations of:

Whole plots

1. **Manure** Fertilizers and organic manures:

N1	Plot 1	N1
K	Plot 2/1	K since 1996 (as 2/2 before)
None (FYM)	Plot 2/2	None (FYM until 1863)
None	Plot 3	None
P	Plot 4/1	P
N2P	Plot 4/2	N2 P
N1PKNaMg	Plot 6	N1 P K Na Mg
(P)KNaMg	Plot 7/1	K Na Mg (+P until 2012)
PKNaMg	Plot 7/2	P K Na Mg
PNaMg	Plot 8	P Na Mg
PKNaMg(N2)	Plot 9/1	P K Na Mg (+ N2 until 1989)
N2PKNaMg	Plot 9/2	N2 P K Na Mg
N2PNaMg	Plot 10	N2 P Na Mg
N3PKNaMg	Plot 11/1	N3 P K Na Mg
N3PKNaMgSi	Plot 11/2	N3 P K Na Mg Si
None	Plot 12	None
(FYM/F)	Plot 13/1	None (FYM/F until 1993/1995)
FYM/PM	Plot 13/2	FYM/PM (FYM/F until 1999)
PKNaMg (N2*)	Plot 14/1	P K Na Mg (+ N2* until 1989)
N2*PKNaMg	Plot 14/2	N2* P K Na Mg
N3*PKNaMg (N2*)	Plot 15	N3*P K Na Mg (N2* until 1875; P K Na Mg 1876-2012)
N1*PKNaMg	Plot 16	N1* P K Na Mg
N1*	Plot 17	N1*
N2KNaMg	Plot 18	N2 K Na Mg
FYM	Plot 19	FYM
FYM/N*PK	Plot 20	FYM/N*P K

N1, N2, N3:	48, 96, 144 kg N as sulphate of ammonia
N1*, N2*, N3*:	48, 96, 144 kg N as nitrate of soda (30 kg N to plot 20 in years with no farmyard manure). In 2013 plot 15 started to receive 144 kg N/ha as nitrate of soda to provide a comparison with plot 11/1, which receives 144 kg N/ha as sulphate of ammonia.

P:	17 kg P/ha applied as triple superphosphate since 2017, except for plot 20 which receives 15 kg P/ha in years with no farmyard manure. Prior to this, 35 kg P (15 kg P to plot 20 in years with no farmyard manure) was applied as triple superphosphate in 1974 and since 1987, single superphosphate in other years.
(P):	In 2013 plot 7 was split into 7/1 & 7/2. P was withheld from plot 7/1 but 7/2 continued to receive P as above.
K:	225 kg K (45 kg K to plot 20 in years with no farmyard manure) as sulphate of potash
Na:	15 kg Na as sulphate of soda
Mg:	10 kg Mg as sulphate of magnesia
Si:	Silicate of soda at 450 kg
FYM:	Farmyard manure at 35 t every fourth year
F:	Fishmeal every fourth year to supply 63 kg N (stopped 1999; replaced by PM)
PM	Pelleted poultry manure at 2 t, every fourth year to supply 63 kg N (started 2003)

Sub-plots

2.	**Lime**	**Liming plots 1-18 (excluding 18/2):**
	a	Ground chalk applied as necessary to achieve pH7
	b	Ground chalk applied as necessary to achieve pH6
	c	Ground chalk applied as necessary to achieve pH5
	d	None

NOTE: A small amount of chalk was applied to all plots during tests in the 1880s and 1890s. A regular test of liming was started in 1903 when most plots were divided in two and 4 t ha^{-1} $CaCO_3$ was applied every four years to the southern half. In 1965, most plots were divided into four: sub-plots “a” and “b” on the previously limed halves and sub-plots “c” and “d” on the unlimed halves. Sub-plots “a”, “b” and “c” now receive different amounts of chalk, when necessary, to achieve and/or maintain soil (0-23cm) at pH 7, 6 and 5, respectively. Sub-plot “d” receives no lime and its pH reflects inputs from the various treatments and the atmosphere. Lime was last applied in 2017-2018; the nineth application in a triennial scheme of soil pH analysis and remedial chalk applications.

[This note was incorrect in earlier Yield book entries.]

NOTE: A separate scheme of liming was introduced on plots 18, 19 & 20 in 1920; subplot /1, /2 and /3 receive no lime, “high” lime and “light” lime respectively every 4 years. Since 1965 plot 18-1 has been split into two for treatments ‘c’ and ’d’ as above and plot 18-3 split into two for treatments ‘a’ and ‘b. Plots 19 and 20 received no further chalk after 1968; plot 18/2 no further chalk after 1972.

[This note was incorrect in earlier Yield book entries. See further details on the e-RA website at http://www.era.rothamsted.ac.uk]

Experimental Diary

Date		Application	Rate	Units
06/11/2018	f	Applied TSP Treatments - plots 4/1,4/2, 6a, 6b, 7/2, 8, 9/1, 9/2, 10, 11/1, 11/2, 14/2, 14/1, 15, 16	83	kg/ha
06/11/2018	f	Applied TSP Treatments - plot 20	73	kg/ha
28/01/2019	f	Sulphate of Potash (50% K2O) - plots 2/1, 6a, 6b, 7/1, 7/2, 9/1, 9/2, 11/1, 11/2, 14/2, 14/1, 15, 16, 18	542	kg/ha
28/01/2019	f	Sulphate of Potash (50% K2O) - plots 20	108	kg/ha
28/01/2019	f	Sulphate of Soda (35% Na) - plots 6a, 6b, 7/1, 7/2, 8, 9/1, 9/2, 10, 11/1, 11/2, 14/2, 14/1, 15, 16, 18	43	kg/ha
28/01/2019	f	Sulphate of Magnesia as Epson Salts (9% Mg) - plots 6a, 6b, 7/1, 7/2, 8, 9/1, 9/2, 10, 11/1, 11/2, 14/2, 14/1, 15, 16, 18	111.1	kg/ha
28/01/2019	f	Silicate of Soda - plots 11/2	450	kg/ha
31/01/2019	f	Poultry Manure - plot 13/2	2	t /ha
01/04/2019	a	Topped paths	-	-
10/04/2019	f	Applied Sulphate of Ammonia (21% N) - plots 1 and 6a, 6b	229	kg/ha
10/04/2019	f	Applied Sulphate of Ammonia (21% N) - plots 4/2, 9/2, 10, 18	457	kg/ha
10/04/2019	f	Applied Sulphate of Ammonia (21% N) - plots 11/1, 11/2	686	kg/ha
10/04/2019	f	Applied Sodium Nitrate (16% N) - plot 20	188	kg/ha
10/04/2019	f	Applied Sodium Nitrate (16% N) - plots 16, 17	300	kg/ha
10/04/2019	f	Applied Sodium Nitrate (16% N) - plots 14/2	600	kg/ha
11/04/2019	f	Applied Sodium Nitrate (16% N) - plots 15	900	kg/ha
11/04/2019	a	Cut Paths	-	-
29/04/2019	a	Cut Paths	-	-
15/05/2019	a	Cut Paths	-	-
24/05/2019	a	topped surrounds and paths	-	-
20/06/2019	a	Cut Paths	-	-
26/06/2019	a	Harvest - 1st Cut for grass yields	-	-
28/06/2019	a	Test Cut plots for yield with Haldrup	-	-
01/07/2019	a	Mowed all grass plots	-	-
02/07/2019	a	turned grass plots	-	-
15/08/2019	a	Path Cutting - Kilworth Topper - Izeki tractor	-	-
17/10/2019	a	Path Cutting - Kilworth Topper - Izeki tractor	-	-
22/10/2019	a	Harvested - 2nd Cut for grass yields - plot 18d second pass moved to south after accident with mower - still full length of plot	-	-
29/10/2019	a	Row up	-	-
30/10/2019	a	Baling	7	bales

NOTE: Samples of herbage (1st and 2nd Cut) were taken for chemical analysis. Unground herbage samples from all plots were archived.

Yields

1ST CUT (26-27 JUN 2019) DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean 4.16

Manure	Lime	a	b	c	d	Mean
N1	1	2.66	2.49	2.03	1.24	2.10
K	2/1	2.46	2.63	1.87	2.49	2.36
None(FYM)	2/2	2.92	2.98	2.41	2.24	2.64
None	3	2.50	2.90	2.51	2.02	2.48
P	4/1	2.72	3.50	3.30	2.83	3.09
N2P	4/2	4.26	4.83	4.81	2.62	4.13
N1PKNaMg	6	5.26	5.81	-	-	5.54
(P)KNaMg	7/1	4.10	5.47	4.97	2.69	4.31
PKNaMg	7/2	3.92	5.49	5.05	4.20	4.66
PNaMg	8	3.13	3.75	4.07	4.75	3.93
PKNaMg(N2)	9/1	4.08	4.99	4.28	1.00	3.59
N2PKNaMg	9/2	5.34	6.07	5.19	4.56	5.29
N2PNaMg	10	4.31	4.60	5.08	3.31	4.32
N3PKNaMg	11/1	5.27	5.78	5.66	4.91	5.41
N3PKNaMgSi	11/2	6.86	6.52	5.66	5.67	6.18
None	12	2.90	2.35	2.68	2.45	2.59
(FYM/F)	13/1	4.00	4.34	4.17	3.75	4.06
FYM/PM	13/2	4.01	5.25	5.22	6.05	5.13
PKNaMg(N2*)	14/1	3.45	4.96	4.79	4.84	4.51
N2*PKNaMg	14/2	5.32	6.06	4.85	6.03	5.56
N3*PKNaMg(N2*)	15	5.45	6.48	5.60	6.15	5.92
N1*PKNaMg	16	4.79	5.27	4.37	4.48	4.73
N1*	17	3.03	3.58	2.71	3.28	3.15

N2KNaMg	18	3.49	3.73	3.26	1.11	2.90
N2KNaMg	18/2	-	-	-	-	3.93
FYM	19/1	-	-	-	-	5.50
FYM	19/2	-	-	-	-	5.62
FYM	19/3	-	-	-	-	5.84
FYM/N*PK	20/1	-	-	-	-	5.75
FYM/N*PK	20/2	-	-	-	-	5.84
FYM/N*PK	20/3	-	-	-	-	5.39

1st cut mean DM% 26.80

2ND CUT (22 OCT 2019) DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean 0.93

Manure	Lime	a	b	c	d	Mean
N1	1	0.90	0.83	0.91	0.42	0.77
K	2/1	0.70	0.60	0.62	0.81	0.68
None(FYM)	2/2	0.80	0.80	1.04	0.91	0.89
None	3	0.86	0.87	1.13	1.01	0.97
P	4/1	1.09	1.18	1.75	1.18	1.30
N2P	4/2	0.57	0.76	0.60	0.60	0.63
N1PKNaMg	6	0.64	0.63	-	-	0.63
(P)KNaMg	7/1	0.79	0.90	0.74	0.72	0.79
PKNaMg	7/2	0.67	0.76	0.82	0.55	0.70
PNaMg	8	0.73	0.57	0.54	0.69	0.63
PKNaMg(N2)	9/1	0.55	0.65	0.48	0.08	0.44
N2PKNaMg	9/2	0.65	0.78	0.38	0.71	0.63
N2PNaMg	10	0.27	0.46	0.67	0.65	0.51
N3PKNaMg	11/1	1.35	1.20	0.83	1.44	1.21
N3PKNaMgSi	11/2	2.20	1.55	1.12	1.58	1.61
None	12	0.52	0.38	0.55	0.43	0.47
(FYM/F)	13/1	0.88	0.81	0.59	0.54	0.70

FYM/PM	13/2	1.27	2.00	1.45	1.21	1.48
PKNaMg(N2*)	14/1	0.57	1.05	1.40	1.35	1.09
N2*PKNaMg	14/2	1.46	1.84	1.54	1.60	1.61
N3*PKNaMg(N2*)	15	1.68	1.81	1.76	1.29	1.63
N1*PKNaMg	16	1.31	1.61	1.17	0.94	1.26
N1*	17	0.89	0.90	0.81	0.81	0.85
N2KNaMg	18	0.46	0.63	0.68	0.24	0.50
N2KNaMg	18/2	-	-	-	-	0.96
FYM	19/1	-	-	-	-	0.95
FYM	19/2	-	-	-	-	1.28
FYM	19/3	-	-	-	-	1.09
FYM/N*PK	20/1	-	-	-	-	1.05
FYM/N*PK	20/2	-	-	-	-	1.22
FYM/N*PK	20/3	-	-	-	-	0.87

2nd cut mean DM% 24.05

TOTAL OF 2 CUTS DRY MATTER, TONNES/HECTARE

Tables of means

Grand mean 5.09

Manure		Lime	a	b	c	d	Mean
N1	1		3.56	3.32	2.94	1.66	2.87
K	2/1		3.16	3.23	2.48	3.30	3.04
None(FYM)	2/2		3.72	3.78	3.46	3.14	3.52
None	3		3.36	3.77	3.64	3.03	3.45
P	4/1		3.81	4.69	5.04	4.01	4.39
N2P	4/2		4.83	5.59	5.42	3.21	4.76
N1PKNaMg	6		5.91	6.43	-	-	6.17
(P)KNaMg	7/1		4.89	6.38	5.70	3.41	5.10
PKNaMg	7/2		4.59	6.25	5.87	4.75	5.36
PNaMg	8		3.86	4.31	4.61	5.44	4.56
PKNaMg(N2)	9/1		4.63	5.64	4.76	1.08	4.03

N2PKNaMg	9/2	5.99	6.85	5.57	5.26	5.92
N2PNaMg	10	4.58	5.05	5.75	3.96	4.83
N3PKNaMg	11/1	6.62	6.98	6.49	6.35	6.61
N3PKNaMgSi	11/2	9.06	8.07	6.78	7.25	7.79
None	12	3.42	2.72	3.23	2.88	3.06
(FYM/F)	13/1	4.88	5.15	4.75	4.29	4.77
FYM/PM	13/2	5.28	7.24	6.66	7.27	6.61
PKNaMg(N2*)	14/1	4.02	6.01	6.19	6.19	5.60
N2*PKNaMg	14/2	6.78	7.89	6.39	7.63	7.17
N3*PKNaMg(N2*)	15	7.13	8.29	7.36	7.44	7.55
N1*PKNaMg	16	6.1	6.87	5.53	5.42	5.98
N1*	17	3.93	4.49	3.52	4.10	4.01
N2KNaMg	18	3.95	4.36	3.94	1.35	3.40
N2KNaMg	18/2	-	-	-	-	4.89
FYM	19/1	-	-	-	-	6.45
FYM	19/2	-	-	-	-	6.90
FYM	19/3	-	-	-	-	6.94
FYM/N*PK	20/1	-	-	-	-	6.80
FYM/N*PK	20/2	-	-	-	-	7.06
FYM/N*PK	20/3	-	-	-	-	6.26

TOTAL OF 2 CUTS
Mean DM% 25.38

19/R/GC/8 GARDEN CLOVER (Manor Garden)

Object: To study yields and pathogens of red clover grown continuously - Manor Garden.

The 166th year, red clover.

For previous years see `Details' 1967 and 1973, and Yield books for 74-18/R/GC/8.

Design: 2 blocks of 2 plots.

Whole plot dimensions: 1.00 m x 1.40 m.

Treatments:

Residual effects of fungicide to control *Sclerotinia trifoliorum*:

NONE None

Benomyl sprays during previous winters, last applied November 1989.

Experimental Diary

Date		Application	Rate	Unit
09/11/2018	f	Applied Epsom Salts by hand	50	kg/ha
09/11/2018	f	Applied TSP by hand	75	kg/ha
09/11/2018	f	Applied SOP by hand	150	kg/ha
09/11/2018	f	Applied Chalk by hand	1.52	t/ha
03/05/2019	p	Applied Major Slug Pellets by hand	5	kg/ha
03/05/2019	a	Re sowed plots by hand with cv Merula	30	kg/ha

Yields (No Yields for 2019: Clover was re-sown, but due to drought conditions there was insufficient growth for a yield to be taken)

19/W/RN/3 LEY/ARABLE (Stackyard D, Woburn Farm)

Object: To compare the effects on soil fertility of rotations with or without leys – Woburn, Stackyard D.

Sponsors: A. J. Macdonald

The 82nd year, leys, winter beans, winter wheat, winter rye

For previous years see 'Details' 1967 & 1973 and Yield Books for 74-18/W/RN/3.

Design: 5 series of 8 plots, split for treatments other than rotations.

Whole plot dimensions: 8.53 m x 40.7 m

Treatments: All phases of four five-course rotations were originally present:

ROTATION

LEY	Clover/grass ley:	L, L, L, P, W
CLO	All legume ley:	SA, SA, SA, P, W until 1971 then CL, CL, CL, P, WINTER
A	Arable with roots:	P, R, C, P, W until 1971 then P, B, B, P, WINTER
A H	Arable with hay:	P, R, H, P, W until 1971 then P, B, H, P, WINTER

P = potatoes, R = winter rye, C = carrots, W= winter wheat, B = spring barley, H = hay, L = clover/grass ley, SA = sainfoin ley, CL = red clover ley.

Rotations themselves followed different cycles:
On four plots in each block the rotations were repeated.
On four plots in each block arable rotations alternated every five years with ley rotations.
From 1976 all the rotations were changed on all phases except for the first and second test crops in 1976:

LN 3	(Previous LEY) LN1, LN2, LN3, W, R
LC 3	(Previous CLO) LC1, LC2, LC3, W, R
AF	(Previous A) F, F, BE, W, R
AB	(Previous A H) B, B, BE, W, R
	From 1988 rotations AF and AB are replaced by AM and ABe respectively. Phased in at the beginning of each treatment crop sequence.
AM	R, BE, M, W, R
ABe	R, M, BE, W, R

LN1 to LN3 = three-year grass ley with N, 1st year to 3rd year,
LC= clover/grass ley, no N, BE = beans (spring oats until 1980), F = fallow,
M = forage maize

Plots hitherto in alternating rotations were changed to test eight-year leys and two test crops:

LLN LLN1, LLN2, LLN3, LLN4, LLN5, LLN6, LLN7, LLN8, W, R
LLC LLC1, LLC2, LLC3, LLC4, LLC5, LLC6, LLC7, LLC8, W, R
LLN1 to LLN8 = eight year grass leys with nitrogen, first year to eighth year, similarly for LLC – clover/grass ley, no nitrogen

The new scheme started by sowing these new leys in spring 1976 on four phases and in spring 1977 on the fifth phase (2nd test crop in 1976).

In 1992 winter rye (R) replaced spring barley (B) as the second test crop. Yields are taken from the leys, arable treatment crops and the test crops.

From 2007 plots previously in the 1st cycle of testing eight-year leys followed by two arable test crops (i.e. those plots which were changed to eight-year ley treatments in 1976 or 1977) changed to a three-year arable rotation followed by two arable test crops. Plots were "phased in" but joined the relevant point in the rotation. From 2008 the second cycle 8-yr grass and grass/clover leys changed to 3-yr grass or grass/clover leys respectively. They were phased in between 2008 and 2012.
LLN/AO (Previously 1st cycle, 8-yr grass ley) R, BE, O, W, R
LLC/ABe (Previously 1st cycle, 8-yr grass/clover ley) R, O, BE, W, R
LLC/LC3 (Previously 2nd cycle, 8-yr grass ley) Lc 1, Lc 2, Lc 3, W, R

LLN/LN3 (Previously 2nd cycle, 8-yr grass/clover ley) Ln 1, Ln 2, Ln 3, W, R

From 2009 W oats (O) replaced forage maize (M) in the AM and ABe rotations on block III and were phased in on blocks V, IV, II and I in subsequent years. The AM treatment was re-named AM/AO. The new rotations were fully in phase by 2016.

Treatments to first test crop winter wheat, all combinations of:

Whole plots:

1. **ROTATION** Rotations before wheat:
   LLN 8
   LN 3
   LLC 8
   LC 3
   LLC/LC3
   LLN/LN3
   LLN/AO
   LLC/ABe
   AM/AO
   ABe
   1/ 2 plots:

2. **NSPLIT (FYM res)** Farmyard manure residues, last applied 1960s:
Split N v single N dressing to wheat, tested 2001-5

Nsplit (noFYM)
Nsingle (FYM)
1/8 plots:

3. **N** Nitrogen fertilizer as split dressings in spring 2019 (kg N) as 34.5% N:

0	0	
80	40 + 40	) to be applied
160	40 + 120	) late-February/early-March
240	40+ 200	) and mid-April

Treatments to second test crop winter rye, all combinations of:

Whole plots:

1. **ROTATION** Rotations before first test crop:
LLN8
LN 3
LLC 8
LC 3
LLC/LC3 not yet in phase
LLN/LN3 not yet in phase
LLN/AO not yet in phase
LLC/ABe not yet in phase
AM/AO
ABe
1/ 2 plots:

2. **NSPLIT (FYM res)** Farmyard manure residues, last applied 1960s:
N split to wheat (no FYM)

N single to wheat (FYM)

1/8 plots:

3. **N** Nitrogen fertilizer in spring 2019 (kg N) as 34.5%:
0
50
100
150

Treatments to leys:

FYM RES Farmyard manure residues:

NONE
FYM 38 t on each occasion, last applied 1960s.

NOTE: Corrective K dressings (kg K_2O ha^{-1}) as muriate of potash, applied where necessary to first test crop winter wheat and long-term leys in the wheat block, applied 2018 (see date below).

Continuous rotations	No FYM	FYM Res
Before wheat	Half plots	Half plots
ABe/Be	330	310
AO/O	300	300
LLn/AO	210	180
LLc/ABe	220	160

None to other plots.

Experimental Diary

Date		Application	Rate	Units
ALL				
24/09/2018	a	Ploughing	-	-
01/04/2019	a	Cultivated with power-harrow	-	-
01/04/2019	a	Rolling	-	-
16/04/2019	a	Topping paths	-	-
21/05/2019	a	Topped paths	-	-
28/06/2019	a	Topped paths	-	-
15/07/2019	a	Baling	-	-
15/07/2019	a	Rowing up	-	-
20/09/2019	a	Rowing up	-	-
21/09/2019	a	Baling	-	-
24/09/2019	a	Topping	-	-
Grass ley and clover/grass leys (first year leys)				
17/10/2018	a	Topping grass	-	-
14/11/2018	f	Applied SOP (50% K2O, 45% SO3); Block 5; Plots 65, 66, 69, 70, 77, 78, 79, 80	140	kg/ha
14/11/2018	f	Applied TSP (46% P2O5); Block 5; Plots 65, 66, 69, 70, 77, 78, 79, 80	213	kg/ha
01/04/2019	a	Seeded by hand - grass only; Plots 65, 66, 69, 70	30	kg/ha

01/04/2019	a	Seeded by hand - grass/clover only; Plots 77 to 80	30	kg/ha
18/04/2019	f	Applied Nitram (34.5% N) - grass only; Block 5; Plots 65, 66, 69, 70	217	kg/ha
18/04/2019	f	Applied MOP (60% K2O); Block 5; Plots 65, 66, 69, 70, 77, 78, 79, 80	167	kg/ha
24/04/2019	f	Applied Nitram (34.5% N) - grass only; Block 5; Plots 65, 66, 69, 70	145	kg/ha
24/04/2019	f	Applied Nitram (34.5% N) - grass/clover only; Block 5; Plots 77 to 80	72	kg/ha
02/07/2019	a	1st Cut	-	-
06/11/2019	a	2nd Cut	-	-
Grass ley and clover/grass leys (2nd and 3rd year leys)				
17/10/2018	a	Topping grass	-	-
14/11/2018	f	Applied SOP (50% K2O, 45% SO3); Blocks 1 and 3; Plots 3, 4, 7, 8, 11, 12, 13, 14, 33, 34, 37, 38, 41, 42, 43, 44	140	kg/ha
14/11/2018	f	Applied TSP (46% P2O5); Blocks 1 and 3; Plots 3, 4, 7, 8, 11, 12, 13, 14, 33, 34, 37, 38, 41, 42, 43, 44	213	kg/ha
18/04/2019	f	Applied Nitram (34.5% N) - grass only; Plots 11 to 14, 37, 38, 43, 44	217	kg/ha
18/04/2019	f	Applied MOP (60% K2O) - grass only; Plots 3, 4, 7, 8, 11 to 14, 33, 34, 37, 38, 41 to 44.	167	kg/ha
02/07/2019	a	1st Cut	-	-
06/11/2019	a	2nd Cut	-	-
W Beans				
14/11/2018	f	Applied TSP (46% P2O5); Plots 1, 2 15, 16, 35, 36, 39, 40	127	kg/ha
16/11/2018	a	Drilled Tundra	50	seeds/m^2
18/04/2019	f	Applied SOP (50% K2O, 45% SO3); Plots 1, 2 15, 16, 35, 36, 39, 40	150	kg/ha
23/04/2019	p	Sprayed bassagran onto beans	1.65	kg/ha
20/06/2019	p	Sprayed Sprinter	3	lt/ha
20/06/2019	p	Sprayed San 703	703	lt/ha

18/09/2019	a	Harvested all Plots - no yields due to insufficient material; odds & ends cleared	-	-
W Wheat				
14/11/2018	f	Applied TSP (46% P2O5); Block 1; Plots 17 to 32	127	kg/ha
14/11/2018	f	Applied MOP (60% K2O) as corrective K; plot 21	160	kg/ha
14/11/2018	f	Applied MOP (60% K2O) as corrective K; plot 28	180	kg/ha
14/11/2018	f	Applied MOP (60% K2O) as corrective K; plot 27	210	kg/ha
14/11/2018	f	Applied MOP (60% K2O) as corrective K; plot 22	220	kg/ha
14/11/2018	f	Applied MOP (60% K2O) as corrective K; Plots 19, 20	300	kg/ha
14/11/2018	f	Applied MOP (60% K2O) as corrective K; plot 18	310	kg/ha
14/11/2018	f	Applied MOP (60% K2O) as corrective K; plot 17	330	kg/ha
15/11/2018	a	Drilled Crusoe trt Redigo Pro	400	seeds/m^2
18/03/2019	f	Applied Nitro-Chalk (27% N) excludes Plots 174, 183, 193, 201, 212, 221, 231, 242, 252, 262, 274, 282, 292, 304, 311, 323	148	kg/ha
16/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 171 ,182 ,194 ,204 ,214 ,223 ,234 ,241 ,251 ,263 ,272 ,283 ,294 ,303 ,314 ,321	148	kg/ha
16/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 172 ,184 ,191 ,202 ,211 ,222 ,232 ,243 ,254 ,261 ,273 ,281 ,291 ,301 ,313 ,324	444	kg/ha
16/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 173 ,181 ,192 ,203 ,213 ,224 ,233 ,244 ,253 ,264 ,271 ,284 ,293 ,302 ,312 ,322	741	kg/ha
18/04/2019	f	Applied SOP (50% K2O, 45% SO3); Plots 171 ,182 ,194 ,204 ,214 ,223 ,234 ,241 ,251 ,263 ,272 ,283 ,294 ,303 ,314 ,321	150	kg/ha
29/04/2019	p	Sprayed Ally Max	42	g/ha
29/04/2019	p	Sprayed Hurler	500	ml/ha

29/04/2019	p	Sprayed Sprinter	2	lt/ha
29/04/2019	p	Sprayed Envoy	1	lt/ha
29/05/2019	p	Sprayed Sprinter	3	lt/ha
29/05/2019	p	Sprayed Cello	1.25	lt/ha
18/09/2019	a	Harvested all Plots; odds & ends cleared	-	-

W Rye

14/09/2018	f	Applied chalk treatments; Block 4	5	t/ha
14/11/2018	f	Applied TSP (46% P2O5); Plots 49 to 64 (Block 4), 67, 68, 71 to 76	127	kg/ha
15/11/2018	a	Drilled Mephisto	350	seeds/m^2
16/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 491 ,501 ,511 ,521 ,531 ,542 ,553 ,562 ,574 ,583 ,592 ,602 ,612 ,623 ,633 ,642	185	kg/ha
16/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 493 ,502 ,514 ,522 ,533 ,544 ,551 ,561 ,573 ,582 ,594 ,604 ,613 ,621 ,631 ,644	370	kg/ha
16/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 492 ,503 ,512 ,524 ,534 ,543 ,554 ,563 ,572 ,584 ,593 ,603 ,614 ,624 ,634 ,641	556	kg/ha
18/04/2019	f	Applied SOP (50% K2O, 45% SO3); Plots 492 ,503 ,512 ,524 ,534 ,543 ,554 ,563 ,572 ,584 ,593 ,603 ,614 ,624 ,634 ,641	150	kg/ha
18/04/2019	f	Applied Nitram (34.5% N); Plots 67, 68, 71, 72, 73, 74, 75, 76	290	kg/ha
29/04/2019	p	Sprayed Ally Max	42	g/ha
29/04/2019	p	Sprayed Hurler	500	ml/ha
29/04/2019	p	Sprayed Sprinter	2	lt/ha
29/04/2019	p	Sprayed Envoy	1	lt/ha
20/06/2019	p	Sprayed Sprinter	2	Lt/ha
20/06/2019	p	Sprayed Cello	1.25	Lt/ha
18/09/2019	a	Harvested all Plots; odds & ends cleared	-	-

W Oats

14/11/2018	f	Applied TSP (46% P2O5); Plots 5, 6 ,9, 10, 45 to 48	127	kg/ha
16/11/2018	a	Drilled Mascani trt Beret Gold	350	seeds/m^2
18/04/2019	f	Applied SOP (50% K2O, 45% SO3); Plots 5, 6 ,9, 10, 45 to 48	150	kg/ha
18/04/2019	f	Applied Nitram (34.5% N); Plots 5, 6, 9, 10, 45 to 48	290	kg/ha
29/04/2019	p	Sprayed Ally Max	42	g/ha
29/04/2019	p	Sprayed Hurler	500	ml/ha
29/04/2019	p	Sprayed Sprinter	2	lt/ha
29/04/2019	p	Sprayed Envoy	1	lt/ha
20/06/2019	p	Sprayed Sprinter	2	Lt/ha
20/06/2019	p	Sprayed Cello	1.25	Lt/ha
18/09/2019	a	Harvested all Plots; odds & ends cleared	-	-

NOTE: Herbage and grain samples were taken for chemical analyses.

Yield Error Note: It was found that the FYM notation (dr) for some plots on Block 5 was incorrect in the 2019 field plan, and for several previous years (2003-2006, 2009). Consequently, the yield and plans for 2019 were corrected, but earlier yield books contain an error in some of the mean yields for FYM and NONE treatments.

LEYS

1ST CUT (02 JUL 2019) DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM_RES			
LEY	NONE	FYM	MEAN
LC1	1.58	2.15	1.87
LC2	2.10	2.51	2.30
LC3	2.35	2.47	2.41
LN1	1.54	1.76	1.65
LN2	7.64	6.17	6.91
LN3	5.80	5.34	5.57
(LLC/LC)LC1	1.48	1.78	1.63

(LLC/LC)LC2	4.06	4.99	4.52
(LLC/LC)LC3	1.86	1.33	1.59
(LLN/LN)LN1	1.01	0.75	0.88
(LLN/LN)LN2	6.21	6.73	6.47
(LLN/LN)LN3	4.91	5.63	5.27
MEAN	3.38	3.47	3.42

1ST CUT MEAN DM% 31.4

2ND CUT (06 NOV 2019) DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM_RES LEY	NONE	FYM	MEAN
LC1	1.83	1.60	1.71
LC2	0.13	0.07	0.10
LC3	-	-	-
LN1	0.80	1.12	0.96
LN2	0.58	0.40	0.49
LN3	-	-	-
(LLC/LC)LC1	1.46	1.31	1.38
(LLC/LC)LC2	0.12	0.18	0.15
(LLC/LC)LC3	-	-	-
(LLN/LN)LN1	0.81	1.50	1.15
(LLN/LN)LN2	0.25	0.51	0.38
(LLN/LN)LN3	-	-	-
MEAN	0.75	0.83	0.79

2ND CUT MEAN DM% 20.40

Note: No 2nd Cut of the third year leys (LC3, LN3, LC3, (LLC/LC)LC3, (LLN/LN)LN3) was taken because they were cultivated before the 06/11/2019 (date of 2nd cut on first and second year leys).

Total of 2 CUTS DRY MATTER TONNES/HECTARE

***** Tables of means *****

FYM_RES LEY	NONE	FYM	MEAN
LC1	3.41	3.75	3.58
LC2	2.22	2.58	2.40
LC3	-	-	-
LN1	2.34	2.88	2.61
LN2	8.22	6.56	7.39
LN3	-	-	-
(LLC/LC)LC1	2.94	3.09	3.01
(LLC/LC)LC2	4.17	5.16	4.67
(LLC/LC)LC3	-	-	-
(LLN/LN)LN1	1.82	2.25	2.03
(LLN/LN)LN2	6.45	7.24	6.85
(LLN/LN)LN3	-	-	-
MEAN	3.95	4.19	4.07
TOTAL OF 2 CUTS MEAN DM%	28.20		

Note: Since 2014 grass-only leys have not been receiving N after the first cut and in some years K has not been applied after the first cut on both grass-only and grass-clover leys.

ARABLE TREATMENT CROPS

WINTER BEANS – No yields due to very poor establishment and growth

RYE (EXTRA)

GRAIN (85% DRY MATTER) TONNES/HECTARE

***** Tables of means *****

FYMRES ROTATION	NONE	FYM	Mean
(AO)R	4.22	3.88	4.05
(LLn/AO)R	5.28	4.11	4.70
(LLc/ABe)R	5.62	5.08	5.35
(ABe)R	4.57	4.36	4.46
Mean	4.92	4.36	4.64

Grain mean DM%	86.2
Plot area harvested	0.00393

WINTER WHEAT

Grain tonnes/hectare
***** *Tables of means* *****

FYMRES ROTATION	none	FYM	Mean
(AO)W	2.55	1.38	1.97
(ABe)W	2.11	2.42	2.26
(LLn/AO)W	3.92	3.12	3.52
(LLc/ABe)W	3.50	3.21	3.36
(LN)W	3.84	2.58	3.21
(LLN/Ln)W	4.39	4.02	4.20
(LC)W	3.22	4.73	3.98
(LLc/Lc)W	3.60	2.16	2.88
Mean	3.39	2.95	3.17

N ROTATION	0	80	160	240	Mean
(AO)W	0.90	2.40	2.04	2.52	1.97
(ABe)W	0.55	2.18	3.04	3.28	2.26

(LLn/AO)W	1.35	4.22	4.83	3.66	3.52
(LLc/ABe)W	1.04	3.64	4.21	4.54	3.36
(LN)W	2.86	4.69	3.40	1.87	3.21
(LLN/Ln)W	2.97	4.24	4.66	4.94	4.20
(LC)W	2.22	4.39	4.55	4.75	3.98
(LLc/Lc)W	1.59	3.48	3.35	3.11	2.88
Mean	1.69	3.65	3.76	3.58	3.17

N	0	80	160	240	Mean
FYMRES					
none	1.71	3.77	4.06	4.02	3.39
FYM	1.66	3.54	3.46	3.15	2.95
Mean	1.69	3.65	3.76	3.58	3.17

N		0	80	160	240
ROTATION	FYMRES				
(AO)W	none	0.75	2.83	3.67	2.95
	FYM	1.05	1.97	0.41	2.10
(ABe)W	none	0.55	2.17	2.84	2.88
	FYM	0.55	2.18	3.23	3.69
(LLn/AO)W	none	1.51	4.42	4.60	5.14
	FYM	1.18	4.03	5.07	2.18
(LLc/ABe)W	none	0.97	3.53	4.85	4.64
	FYM	1.11	3.74	3.57	4.44
(LN)W	none	3.08	4.56	5.63	2.08
	FYM	2.65	4.82	1.18	1.65
(LLN/Ln)W	none	2.94	5.08	4.19	5.34
	FYM	3.00	3.41	5.14	4.53
(LC)W	none	1.40	3.99	3.43	4.04
	FYM	3.03	4.78	5.67	5.45
(LLc/Lc)W	none	2.45	3.56	3.30	5.10
	FYM	0.73	3.40	3.40	1.12
Mean		1.69	3.65	3.76	3.58

Grain mean DM%	85.70
Plot area harvested	0.00183

WINTER RYE

Grain tonnes/hectare

Tables of means

FYMRES ROTATION	none	FYM	Mean
(AO)R	5.90	5.92	5.91
(ABe)R	5.08	4.95	5.02
(LLn/AO)R	6.56	6.84	6.70
(LLc/ABe)R	5.89	5.55	5.72
(Ln)R	6.48	5.95	6.22
(LLn/Ln)R	5.88	7.17	6.53
(Lc)R	6.97	7.45	7.21
(LLc/Lc)R	6.50	7.28	6.89
Mean	6.16	6.39	6.27

N ROTATION	0	50	100	150	Mean
(AO)R	3.49	5.45	7.17	7.54	5.91
(ABe)R	2.85	5.13	6.26	5.84	5.02
(LLn/AO)R	5.41	6.53	6.93	7.93	6.70
(LLc/ABe)R	3.84	5.52	6.86	6.65	5.72
(Ln)R	4.34	6.66	7.02	6.86	6.22
(LLn/Ln)R	5.49	7.37	7.03	6.22	6.53
(Lc)R	5.98	8.34	7.51	7.01	7.21
(LLc/Lc)R	6.03	6.87	8.23	6.41	6.89
Mean	4.68	6.49	7.13	6.81	6.27

N FYMRES	0	50	100	150	Mean
none	4.54	6.45	7.26	6.39	6.16

FYM	4.82	6.52	6.99	7.23	6.39
Mean	4.68	6.49	7.13	6.81	6.27

	N	0	50	100	150
ROTATION	FYMRES				
(AO)R	none	3.51	5.45	7.46	7.19
	FYM	3.47	5.45	6.89	7.89
(ABe)R	none	2.83	5.20	6.85	5.43
	FYM	2.86	5.06	5.66	6.24
(LLn/AO)R	none	4.90	6.39	6.33	8.61
	FYM	5.92	6.67	7.54	7.25
(LLc/ABe)R	none	4.29	5.57	7.55	6.15
	FYM	3.39	5.48	6.16	7.16
(Ln)R	none	4.79	7.09	7.26	6.79
	FYM	3.89	6.22	6.78	6.92
(LLn/Ln)R	none	4.77	7.24	7.17	4.35
	FYM	6.20	7.51	6.88	8.10
(Lc)R	none	5.66	7.98	7.27	6.99
	FYM	6.31	8.71	7.76	7.02
(LLc/Lc)R	none	5.55	6.66	8.21	5.58
	FYM	6.51	7.09	8.26	7.25
	Mean	4.68	6.49	7.13	6.81

Grain mean DM%	85.50
Plot area harvested	0.00183

WINTER OATS

GRAIN (85% DRY MATTER) TONNES/HECTARE

Tables of means

FYMRES	NONE	FYM	Mean
ROTATION			
ABe	2.81	3.36	3.09
AO	1.22	0.99	1.10

LLc/ABe	3.28	3.14	3.21
LLn/AO	0.82	1.08	0.95
Mean	2.03	2.14	2.09

Grain mean DM%	88.20
Plot area harvested	0.00393

Note: Grain and herbage samples were taken for chemical analyses and archiving.

19/W/RN/12 ORGANIC MANURING (Stackyard B, Woburn Farm)

Object: To study, from crop yields and soil analyses, the effects of a range of types of organic matter – Woburn, Stackyard B.

Sponsors: A. J. Macdonald

The 55th year, Spring Barley.

For previous years see 'Details' 1973 and Yield Books for 74-18/W/RN/12.

Design: 4 blocks of 8 plots

Whole plot dimensions: 8.0 m x 29.5 m (8.0 m x 26.5 m on Block III).

Treatments: From 1966 to 1971 the experiment had a preliminary period designed to build up organic matter from different sources. An arable rotation was started on two blocks on 1972 and the remaining two blocks in 1973. After a period of testing the residues, a further period of accumulation was started; on two blocks (which included ley sown in 1979) in 1981 and on the other two (which included ley sown in 1980) in 1982. A second test phase began when leys on the first pair of blocks were ploughed for the 1st test crop in 1987 and on the second pair for the 1st test crop in 1988. From 1988 two blocks, and 1989 the other two, to 1994, plots were split into 6 sub-plots to test five levels of nitrogen and nil. From 1995 to 1997 residual effects of that nitrogen were measured. In 1998 to 2000 yields were taken from whole plots only. In 2001 plots were split into half-plots to test two rates of N.

For 2003 the experiment was modified to test further inputs of organic matter. An arable rotation (winter rye, spring barley, winter beans, winter wheat, forage maize) was started on seven plots within each block; the eighth was sown to a grass/clover ley.

Whole plots

1. **Treatment** (Not necessarily applied each year):

1966-1971/2	1979/82-1986/7	Since 2003
Fd	Fd	F
Ln	Lc6	F
St	St	St
Gm	Lc8	CC
Pt	Lc8	Co
Fs	Fs	Dg10
Dg	Dg	Dg25
Lc	Lc6	Lc

F: no organic amendment. St: chopped straw at 7.5t/ha. CC: cover crop prior to spring sown crops. Co: compost at 40t/ha. Dg10: FYM at 10t/ha. Dg25: FYM at 25t/ha. Dg: FYM at 50t/ha. Fd: fertilizers equivalent to FYM. Fs: fertilizers equivalent to straw (+P). Lc/Lc6/Lc8: grass/clover leys. Ln: grass ley + N. Gm: green manure. Pt: peat.

Since 2003, all treatments, except Dg25, have also received PKS fertilizers:

20 kg P/ha, 83 kg K/ha, 36 kg S/ha

In addition, in 2003 F and CC treatments received 120 kg N/ha, St received 90 kg N/ha. Dg10 received 60 kg N/ha. No N was applied to Dg25, Co or Lc treatments.

Nitrogen

In 2008 all plots, except Lc (permanent grass/clover), split into 6 to test rates of N. For crops receiving nitrogen rates rotate as follows:

N0 > N1 > N2 > N3 > N4 > N5 > N0 etc.

For 2014 Spring barley rates were 0, 35, 70, 105, 140 & 175 kg N/ha as Nitro-chalk (27% N)

For 2015 Winter beans – No Nitrogen Applied

For 2016 Winter wheat rates were 0, 50, 100, 150, 200 & 250 kg N/ha as Nitro-Chalk (27% N)

For 2017 Forage maize rates were 0, 50, 100, 150, 200 & 250 kg N/ha as Nitro-Chalk (27% N)

For 2018 Winter rye rates were 0, 30, 60, 90, 120 & 150 kg N/ha as Nitro-chalk (27% N)

Experimental Diary

Date		Application	Rate	Units
17/09/2018	a	Powerharrowed	-	-
22/09/2018	a	Rolled 4 plots	-	-
22/09/2018	a	Hand sowed mustard	10.00	kg/ha
16/10/2018	a	Completed grass sampling	-	-
17/10/2018	a	Topping grass	-	-
20/02/2019	f	Applied FYM by hand; Plots 008, 014, 018, 028	10.00	t /ha
20/02/2019	f	Applied FYM by hand; Plots 005, 011, 023, 026	25.00	t /ha
21/02/2019	f	Applied Compost by hand; Plots 007, 012, 021, 027	40.00	t /ha

25/02/2019	f	Applied Straw by hand; Plots 003, 015, 017, 031	7.50	t /ha
25/02/2019	a	Topped Straw with topper 9	-	-
25/02/2019	f	Applied TSP	97.00	kg/ha
25/02/2019	f	Applied SOP	200.00	kg/ha
26/02/2019	a	Ploughing	-	-
26/02/2019	a	Powerharrowing	-	-
27/02/2019	a	Rolling	-	-
27/02/2019	a	Ploughing	-	-
27/02/2019	s	Drilled Spring Barley	350.00	seeds/m^2
28/02/2019	a	Powerharrowing	-	-
17/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 0023, 0034, 0042, 0051, 0061, 0074, 0086, 0094, 0103, 0114, 0125, 0141, 0152, 0165, 0172, 0183, 0191, 0204, 0216, 0221, 0234, 0254, 0264, 0275, 0281, 0306, 0316, 0321	130.00	kg/ha
17/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 0026, 0031, 0041, 0052, 0066, 0075, 0081, 0096, 0101, 0115, 0122, 0145, 0151, 0161, 0174, 0184, 0196, 0203, 0213, 0224, 0233, 0251, 0261, 0276, 0285, 0301, 0314, 0322	259.00	kg/ha
17/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 0024, 0032, 0045, 0053, 0065, 0074, 0084, 0093, 0106, 0116, 0126, 0146, 0155, 0163, 0171, 0185, 0193, 0202, 0215, 0226, 0235, 0256, 0266, 0272, 0282, 0304, 0311, 0325	389.00	kg/ha
17/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 0021, 0036, 0046, 0055, 0063, 0072, 0083, 0092, 0104, 0113, 0124, 0143, 0153, 0166, 0173, 0186, 0195, 0206, 0212, 0222, 0232, 0253, 0263, 0274, 0286, 0303, 0313, 0324	519.00	kg/ha
17/04/2019	f	Applied Nitro-Chalk (27% N) by hand; Plots 0022, 0035, 0043, 0056, 0062, 0071, 0082, 0095, 0105, 0112, 0121, 0144, 0156, 0164, 0175, 0182, 0194,	648.00	kg/ha

		0205, 0214, 0225, 0231, 0255, 0265, 0271, 0283, 0302, 0315, 0326		
21/05/2019	a	Topped paths	-	-
25/05/2019	p	Sprayed Sprinter	3.00	lt/ha
25/05/2019	p	Sprayed Refine Max SX	75.00	gm/ha
25/05/2019	p	Sprayed Cello	1.25	lt/ha
25/05/2019	p	Sprayed Starane Hi-Load HL	0.40	lt/ha
20/06/2019	p	Sprayed Sprinter; Sp Barley only	2.00	lt/ha
20/06/2019	p	Sprayed Cello; Sp Barley only	1.25	lt/ha
28/06/2019	a	Topped Paths	-	-
02/07/2019	a	1st Cut	-	-
15/07/2019	a	Rowing up	-	-
17/09/2019	a	Harvested All Plots; Odds & Ends cleared	-	-
20/09/2019	a	Rowing up	-	-
07/11/2019	a	2nd Cut	-	-

Yields

SPRING BARLEY

GRAIN TONNES/HECTARE (85% DM)

Tables of means

Nitrogen Treatment	0	35	70	105	140	175	Mean
F(Fd)	0.61	1.06	1.31	1.77	1.39	1.49	1.27
F(Ln, Lc6)	0.54	1.82	1.79	2.71	2.31	3.05	2.04
St(St)	0.82	2.01	3.06	3.20	2.74	2.56	2.40
CC(Gm, Lc8)	0.97	1.65	1.71	2.75	2.03	2.53	1.94
Co(Pt, Lc8)	2.39	3.03	3.33	4.12	3.95	3.96	3.46
Dg10(Fs)	1.32	1.98	3.06	2.64	2.73	3.17	2.48
Dg25(Dg)	2.38	3.22	3.51	4.06	3.92	3.44	3.42
Mean	1.29	2.11	2.54	3.04	2.73	2.89	2.43

Standard errors of differences of means

Table	Treatment	Nitrogen	Treatment Nitrogen
rep.	24	28	4
s.e.d.	0.532	0.172	0.675
d.f.	18	105	43.90

Except when comparing means with the same level(s) of Treatment	0.455
d.f.	105

Grain Mean DM (%) 84.40

Plot area harvested (ha) 0.00063

GRASS/CLOVER

DRY MATTER TONNES/HECTARE

***** Table of means *****

Year	1st Cut	2nd Cut	Total
2003	-	-	-
2004	1.82	-	1.82
2005	1.86	0.13	1.99
2006	4.07	-	4.07
2007	3.12	1.36	4.48
2008	5.72	1.65	7.37
2009	4.77	-	4.77
2010	4.41	-	4.41
2011	1.46	0.39	1.85
2012	4.11	0.64	4.75
2013	4.65	0.60	5.24
2014	4.09	0.91	5.01
2015	*	0.36	-
2016	3.97	0.56	4.54
2017	2.17	1.48	3.65
2018	2.98	0.93	3.91
2019	2.34	0.39	2.73

Cut dry matter t/ha (02 JUL 2019 & 07 NOV 2019)

Note: Barley grain and herbage samples were taken for chemical analyses and archiving.

Weather Summaries

Rothamsted Research - Harpenden
The weather: Monthly Summary: 2019
(Departure from the 30 year means (1981 - 2010) in brackets)

	Sunshine		Mean Temperatures								Rain			Drainage	Wind
			Maximum		Minimum		Dew Point	Ground	In ground under grass		Total		days**	20"	
								frosts*	30 cm	100 cm	Tipping bucket within turf wall				
	Hours	(hrs)	°C	(°C)	°C	(°C)	°C		°C	°C	mm	(mm)		mm	km/hr***
January	83.6	(+21.53)	6.17	(-0.54)	0.65	(-0.55)	0.69	17	5.83	7.80	34.8	(-35.17)	10	10.7	8.3
February	137.7	(+57.44)	10.89	(+3.97)	1.55	(+0.62)	3.74	21	5.40	6.56	43.2	(-6.94)	17	28.8	8.2
March	148.0	(+33.11)	11.39	(+1.50)	4.33	(+1.67)	4.87	11	7.77	7.68	60.4	(+9.60)	19	27.0	11.3
April	191.6	(+30.40)	13.93	(+1.30)	3.62	(-0.41)	4.96	16	9.29	8.76	13.2	(-41.86)	13	0.1	7.8
May	206.4	(+11.81)	16.32	(+0.24)	6.35	(-0.52)	7.50	9	12.03	10.52	42.8	(-11.89)	15	5.0	6.3
June	178.1	(-20.02)	19.29	(+0.16)	10.16	(+0.41)	11.00	3	14.59	12.61	70.8	(+17.54)	17	******	7.0
July	189.5	(-15.64)	23.13	(+1.36)	12.97	(+1.07)	12.84	0	17.23	14.94	45.0	(-4.87)	10	******	7.6
August	215.3	(+19.07)	23.16	(+1.59)	12.38	(+0.54)	13.09	0	17.20	15.84	45.2	(-18.53)	14	1.5	7.1
September	173.4	(+30.02)	19.46	(+1.18)	10.31	(+0.39)	10.67	3	15.50	15.30	75.0	(+17.37)	14	26.0	7.4
October	91.1	(-20.65)	13.84	(-0.21)	7.15	(+0.02)	8.83	7	12.93	13.71	109.6	(+27.92)	25	61.8	7.4
November	56.9	(-13.85)	8.92	(-0.80)	3.35	(-0.45)	4.81	11	8.94	10.74	91.0	(+14.37)	24	61.9	7.1
December	74.9	(+21.13)	8.77	(+1.88)	2.79	(+1.13)	4.24	14	6.88	8.55	111.6	(+42.08)	26	97.9	8.9
Year	1746.6	(+154.35)	14.60	(+0.97)	6.30	(+0.33)	7.27	112	11.13	11.08	742.60	(+9.62)	204	320.8	7.86

Year total doesn't include June and July

* Number of nights grass minimum was below 0.0 °C
** Number of days rain was 0.2 mm or more
*** At 2 metres above the ground

Woburn Experimental Farm
The Weather : Monthly Summary : 2019
(Departure from 30-year means (1981 - 2010) in brackets)

	Sunshine		Mean Temperatures								Rain			Wind
			Maximum		Minimum		Dew Point	Ground	In ground under grass		Total		days **	***
								frosts *	30 cm	100 cm	Tipping bucket			
	Hours	(hrs)	°C	(°C)	°C	(°C)	°C		°C	°C	mm	(mm)		km/hr
January	75.8	(+15.75)	6.7	(-0.37)	0.5	(-0.77)	0.9	18	5.9	8.4	27.2	(-27.33)	12	7.9
February	140.9	(+65.97)	11.8	(+4.49)	1.4	(+0.54)	4.3	16	5.6	7.1	38.6	(-3.56)	15	8.4
March	144.9	(+31.40)	12.1	(+1.75)	4.2	(+1.56)	5.1	15	8.0	7.9	45.2	(-0.71)	17	11.2
April	193.4	(+42.49)	15.0	(+1.93)	1.8	(-1.96)	5.1	23	9.5	8.7	16.6	(-35.61)	12	5.9
May	215.0	(+27.81)	17.2	(+0.63)	5.5	(-1.07)	7.8	13	13.0	10.5	36.8	(-16.46)	14	6.2
June	180.4	(-7.56)	19.8	(+0.21)	10.1	(+0.71)	11.4	1	16.1	12.9	88.8	(+38.73)	17	7.5
July	205.5	(+8.43)	23.7	(+1.61)	12.2	(+0.59)	13.3	0	19.2	15.4	36.4	(-13.49)	13	6.2
August	224.6	(+35.74)	23.8	(+1.87)	12.4	(+0.84)	13.4	0	18.3	16.6	39.2	(-18.60)	13	8.5
September	182.6	(+45.55)	20.2	(+1.56)	9.4	(-0.25)	11.0	3	15.9	16.1	71.6	(+14.49)	15	7.9
October	79.2	(-32.54)	14.1	(-0.37)	6.5	(-0.42)	8.8	10	12.5	14.5	103.2	(+32.37)	20	7.2
November	53.6	(-12.66)	9.1	(-0.84)	3.0	(-0.78)	5.0	15	8.1	11.4	95.8	(+33.33)	25	5.8
December	70.7	(+25.07)	9.0	(+1.84)	2.7	(+1.23)	4.4	14	6.1	9.0	92.6	(+36.85)	26	8.9
Year	1766.52	(+245.46)	15.32	(+1.21)	5.86	(+0.03)	7.60	128	11.60	11.63	692.0	(+40.00)	199	7.72

* Number of nights grass minimum was below 0.0 °C

** Number of days rain was 0.2 mm or more

*** At 2 metres above ground